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A SHORT INTRODUCTION TO LOGIC

P. C. MUNUSWAMY, M. A.

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A SHORT INTRODUCTION TO LOGIC.

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(Lecturer in Philosophy, Pachiyappa's College, Madras)

(Specially written for the use of Intermediate Students containing various worked-out examples and the Madras University Intermediate Question Papers from March to March).

1934

Gordon & Co.,

328, T. H. ROAD, OLD WASHERMANPET, MADRAS.

Price 1-0-0.

தமிழ்நாடு ஆவணக்காப்பக நூலகம்
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PREFACE.

This book is specially written for the use of Intermediate students. Since there can hardly be any scope to be original in a book of this kind, the author gratefully acknowledges his indebtedness to various writers on logic. There is an attempt made to give corresponding Indian names to some of the technical terms in logic. However it must be understood that the author has not endeavoured to present a comparative study of logic. The purpose of the book is both practical and theoretical. Generally the students find it hard to apply rather than to understand the logical principles. Hence the author has given a number of worked-out examples. In the selection of exercises he has chiefly confined his attention to Creighton: *Introductory Logic*, Latta & Macbeath: *The Elements of Logic* and Bartlett: *Questions in Logic*. It is hoped that the book will perfectly satisfy the requirements of the Intermediate examination of any university.

July 1934
Madras

The author

4 AUG 1934

CONTENTS.

Part I—Deduction. Page

CHAPTER I.

1.	Introduction	1
2.	Logic as a Formal Science	1
3.	Is Logic a science or an Art?	2
4.	Logic and Psychology	3
5.	Logic and Language	5
6.	Logic and Rhetoric	5
7.	Logic and Grammar	6
8.	Various Definitions of Logic	6
	Exercise I	7

CHAPTER II.

Terms.

1.	Singular and General	10
2.	Collective and Distributive	10
3.	Concrete and Abstract	11
4.	Positive and Negative	12
5.	Absolute and Relative	13
6.	Connotative and Denotative	14
7.	Categorematic and Syncategorematic	19
8.	Univocal and Equivocal	19
	Various exercises worked out	19
	Exercise II	21

CHAPTER III.

1.	The Tree of Classification	23
2.	Predicables	25
	Various exercises worked out	26
	Exercise III	27

CHAPTER IV.

Definition and Division

1.	Definition	28
2.	Division	30
3.	The relation between Definition and Division	33

4. Classification . 33
Various exercises worked out . 34
Exercise IV . 38

CHAPTER V.

Propositions.

1. The Nature of Proposition . 40
2. The Quality and Quantity of Propositions 40
3. Import of Propositions . 41
4. Diagrammatic representation of propositions 42
Various exercises worked out . 44

CHAPTER VI.

1. The opposition of Propositions . 48
Various exercises worked out . 49
Exercise V . . . 51

CHAPTER VII.

Immediate Inference.

1. Obversion 52
2. Conversion . . . 52
3. Obverted Conversion . . 53
4. Contraposition . . . 53
5. Inversion 54
6. Immediate Inference by Added Determinents 55
Various exercises worked out . 55
Exercise VI . . . 63

CHAPTER VIII.

Syllogism.

1. The Structure of Syllogism . . 66
2. The Rules of Syllogism . . 67
3. The Figures of Syllogism . . 70
4. The Moods of Syllogism . . 70
5. The Special Canons of the Four figures 71
Various exercises worked out . 74
6. The Determination of Valid Moods . 80
7. The Mnemonic terms . 80

8. The Strengthened and weakened Syllogisms . . 81
9. Dictum de omni et nullo . . 82
10. Reduction . . 82
Various exercises worked out . 87
Exercise VII . . 88

CHAPTER IX.

Abbreviated Arguments.

1. Enthymeme . . 90
2. The Chains of Reasoning . . 91
3. Sorites 93

CHAPTER X.

1. Hypothetical Syllogism . . 95
2. Disjunctive Syllogism . . 97
3. Dilemma 97
Various exercises worked out (including syllogism) 100
Exercise VIII . . . 107

Part II—Induction.

CHAPTER XI.

1. The Problem of Induction . . 115

CHAPTER XII.

1. The Stages in Inductive Procedure . 117
Exercise IX 119

CHAPTER XIII.

1. 'Perfect' and 'Imperfect' induction of Jevons 120
2. Parity of Reasoning . . 121
3. Colligation of Facts . . 121
4. Enumerative Induction . . 122
Exercise X . . 125

CHAPTER XIV.

1. The Postulate of Induction . . 126
Exercise XI 129

CHAPTER XV.

1. The Theory of Causation . . 130
Exercise XII . . . 135

CHAPTER XVI.

1. Observation and Experiment . . 136
Exercise XIII . . . 141

CHAPTER XVII.

1. Statistics . . . 143
2. Calculation of Chances . . 145
Exercise XIV . . . 146

CHAPTER XVIII.

1. The Method of Agreement . . 147
2. The Method of Difference . 151
3. The Joint Method of Agreement and Difference 155
4. The Method of Concomitant Variations 158
5. The Method of Residues . . 161
6. Mill's Nethods Weapons of Elimination 163
Exercise XV . . . 164

CHAPTER XIX.

1. Analogy . . . 165
Exercise XVI . . . 168

CHAPTER XX.

1. Hypothesis . . . 169
Exercise XVII . . . 173

CHAPTER XXI.

1. Explanation . . . 174
Exercise XVIII . . . 175

CHAPTER XXII.

1. The Relation between Deduction and Induction 176
Exercise XIX . . . 177
Various exercises worked out in Induction 179
Exercise XX . . . 182

CHAPTER XXIII.

I. Fallacies 185
Various exercises worked out . 188
Exercise XXI . . . 191

The Madras University Intermediate Question Papers (1931 March—1934 March) . 193

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CHAPTER I

DEFINITION AND SCOPE OF LOGIC

1. Introduction

Logic is the science of thinking. In Sanskrit it is called *'tarka sastra'* or *'nyaya sastra'*. It deals with the principles that are involved in thinking. Each science deals with a particular subject-matter, for example, astronomy deals with the heavenly bodies, and botany with the plants. But logic deals with thought; it studies the ways in which we think about things. We see smoke and know there is fire. The above example indicates in a rough way what thinking is. Thinking is an intellectual process by means of which we get knowledge. Logic, then, is the science which is concerned with the rules or laws of thinking.

Physics deals with the visible and tangible objects such as matter, sound, light, force etc. Such sciences which deal with external phenomena are called objective sciences. But logic is a *subjective science* since it deals with mental activity.

2. Logic as a Formal Science

If we define logic as the science of thought we are in danger of identifying logic with the totality of knowledge. And naturally logic will be the study of all sciences. Logic does not deal with concrete things like stones or gases, but with the universal principles involved in all thinking. In a word, it is concerned with thought-process. Logic deals with the form of thought and not with the matter of

thought. It must however be remembered that there can be no form without matter. This can be understood by means of an illustration. The processes of addition and subtraction can be explained without any reference to what the numbers actually represent. In the same way, logic also studies the forms or types of thought, without any reference to actual concrete particulars thought about. Hence logic is generally called as the *science of sciences*. But it must be remembered that thinking always implies a reference to objects. To think is to think about something. As Joseph remarks "Logic is the science which studies the general principles in accordance with which we think about things whatever things they may be".

3. Is Logic a Science or an Art?

A science *(sastra)* is exact, comprehensive and systematic body of knowledge dealing with any subject. Logic possesses these features. It studies the exact principles or rules in our thinking. It is comprehensive since it deals with various thought-processes such as judgment, inference etc. It is systematic since it explains the intellectual processes as connected with one another.

Then, is it purely a science? Is it an art also? Art (*kala*) is a body of rules for performing some work. Music is an art since we can lay down certain rules for singing. Art gives practical guidance to do something. But every art presupposes a knowledge of other sciences. e. g., Navigation depends on mathematics, astronomy, meteorology etc. Medicine as the art of healing is based on the sciences of chemistry, physiology etc. Thus we find every art depends on the principles of science. Art then is the application of scientific knowledge to some

practical purpose. Science teaches us to *know*; but art teaches us to *do*. The difference between science and art is similar to that of theory and practice.

It must be evident from the above that logic must be a science before it can be an art. Does it not give us definite rules for correct reasoning? It does not even attempt to teach men to reason accurately; it only gives the principles or rules to which accurate reasoning conforms. A man may be able to arrive at a true conclusion and yet have never learned logic; and on the other hand, one may know all the logical principles and yet may reason falsely. In the same way a mere study of ethics cannot make us moral.

But the study of logic is not completely devoid of any utility. The use of logic is the mental discipline which it creates in us. It trains the mind in reasoning faculty. As Creighton says, "It engenders the habit of criticising propositions and examining the evidence upon which they rest." It has a great educative value since it develops the knowing power of man. Its value is mainly negative; it teaches us to avoid mistakes in our own thinking and to correct mistakes in the thoughts and reasonings of other people. It develops a critical habit of mind. Inductive logic is a good mental discipline for every student of science. A number of technical terms of logic have entered into language to such an extent that it is hard to appreciate the books on literature and science without a knowledge of them. We conclude then that logic is more a science than an art.

4. Logic and Psychology

Logic, as we have already seen is the science of thinking. Psychology is also the science of

thinking. If so, what is the difference between the two sciences? No doubt these two sciences deal with the same subject matter. But psychology deals with all mental processes such as thinking, emotion, memory etc; whereas logic is concerned only with thinking. Logic deals with a part of the mind; but psychology studies the mind in its entirety.

Logic not only differs from psychology by being less inclusive but also from stand-point. The relation between psychology and logic can be best understood by considering the difference between the natural and normative science. A natural science deals with the nature of objects as such *i.e.*, with the external shape, form, structure etc. It describes the nature of things as it is. In short, it is positive in its scope. Physics, chemistry, botany, zoology are natural sciences since they describe the nature of things as it is without any purpose in view. We merely study the laws that govern their behaviour. But there are certain other sciences called normative sciences like ethics, aesthetics etc. The object of these sciences is not to study the nature of things as it is, but to study them with reference to an end in view. They aim at ideals. The natural sciences are concerned with *facts* whereas the normative sciences with *value*. In ethics we do not study the nature of moral action but study whether a particular course of action is right or wrong. A normative science aims at a standard or norm. The three important normative sciences are logic, aesthetics and ethics. They respectively aim at truth, beauty and goodness.

Then, logic differs from psychology by standpoint; the one is the normative science of thought and the other the natural science of thought. Psychology describes thought as such without any reference to an end. It does not concern itself with the value of thought *i.e.*, whether a given argument

is true or false. But in logic that is the most important question. Hence for logic thoughts are either true or false *i.e.*, they conform or do not conform to the standard of truth. In a word, psychology is descriptive: logic is regulative; it furnishes the criterion or standard by which false reasoning may be discriminated from true. It does not enquire how men do think, but lays down laws in accordance with which they should think.

This difference is similar to that of ethics and psychology. Ethics is the normative science of conduct whereas psychology is the positive science of conduct. Both study human conduct; but psychology gives a natural account of conduct. It is concerned with the springs of human action; it describes how motives, desires, habits etc., are formed. But ethics is the normative science of conduct. It deals with the ideal involved in conduct. Its question is to find out whether a particular course of action is moral or immoral, good or bad. It evaluates human action with reference to 'goodness' which is its standard. Hence we conclude that logic is the normative science of thought whereas psychology is the positive science of thought.

5. Logic and Language

There is a close relation between logic and language. Our ideas are expressed in language. Logic deals with language in so far as it is the expression of thought. It deals exclusively with thought products as they exist in the mind. Can we think without language? Stout gives chess playing as an example where we think without words. But in all complex processes of thinking, language is indispensable and necessary.

6. Logic and Rhetoric

Logic is chiefly concerned with reasoning or argumentation. Rhetoric is also concerned with

argumentation or proof. But they differ in methods: the one is the art of reasoning and the other the art of persuasion. The logician appeals to the head whereas the rhetorician appeals to the heart.

7. Logic and Grammar

Grammar is the science of the right use of language. But logic deals with meaning. A statement like 'John is a crow because he is black' may be grammatically correct but logically wrong. Grammar deals with the *correctness of language*; but logic deals with the *correctness of thought*. Hence logic is generally called 'the grammar of thought'.

8. Various Definitions of Logic

(1) Logic is the science of the operations of the understanding, which are concerned in, or subservient to, the estimation of evidence" (Mill).

Criticism :—This definition states all the processes of thought that are included in logic. This is a comprehensive definition. Further it also deals with 'estimation of evidence' i.e., with normative aspect of thought. This definition is very satisfactory; but it makes logic a science of mere consistency and not of truth.

(2) 'Logic is the science of formal consistency'

Criticism :—Traditional logic is a formal science *par excellence*. It is concerned only with formal correctness and not with factual correctness. Logic is not only concerned with formal validity but also with material validity, for there can be no form without matter. A syllogism may be formally valid but materially false e.g.,

All crows are birds

All men are crows

∴ All men are birds

Hence it is wrong to say that logic deals with mere consistency.

(3) "Logic is the science of the principles which regulate valid thought". (Welton)

Criticism :—This definition makes logic purely a formal science. But logic deals with the general characteristics of knowledge. It can never be separated from its close connection with knowledge.

(4) "Logic is the science of general principles in accordance with which we think about things, whatever things they may be". (Joseph).

Criticism :—This definition is very satisfactory as it brings out the intimate relation between logic and knowledge. This definition does not narrow the scope of logic to formal treatment. But it fails to include the genetic aspect of thought.

(5) "Logic is the science of knowledge or more exactly is the science of the intellectual processes operative in the acquisition and in the creation of knowledge." (Robinson).

Criticism :—This is the most satisfactory definition. This brings out both the normative and genetic aspect of thought. It ignores mere formalism of logic and insist on its intimate connection with knowledge.

EXERCISE I.

I "Logic deals with the form and not the matter of thought." Carefully consider the statement and distinguish Logic (a) from Psychology (b) from Grammar.

II Discuss the ways in which logic and psychology respectively deal with thought.

III What do you understand by (a) the form and (b) the matter of thought? In what sense, if any, is logic concerned with the matter of thought?

IV Explain and exemplify the distinction between positive and normative science. Is there any sense in which logic can be regarded as a positive science?

V Give what you consider to be a satisfactory definition of logic and examine its relation to psychology. (1928)

VI Discuss the following definitions.

(a) "Logic is the science of the operations of the

understanding, which are concerned in, or subservient to, the estimation of evidence". (1924)

(b) Logic is the science of consistency.

VII "Logic is a formal, subjective and normative science of thought". Explain

VIII Is Logic a science, an art or both?

IX State the relation between logic and (1) language (2) grammar (3) rhetoric.

CHAPTER II

TERMS

Judgment is the unit of thought. If it is expressed in words, it becomes a proposition which has three parts viz., (1) subject (2) predicate and (3) copula. These distinctions are not grammatical parts of a sentence. In the proposition, 'Iron is heavy' 'Iron' is the subject 'is' copula and 'heavy' is the predicate. All the propositions can be put in the above logical form e.g., 'Cow has four legs' can be put thus: Cow is an animal having four legs, here 'cow' is the subject, 'is' copula, 'an animal having four legs' is the predicate. A logical term is any word or group of words which can be used used as a subject or predicate in a proposition. A *name* is a conventional symbol used to designate a particular thing, *e.g.*, water sun, etc. A *term* is a name considered as a part proposition. A *concept* is a general meaning or an idea; it does not refer directly to any object of sense. Thus my direct experience of a tree before me is a percept; the general idea of tree which I use when I say 'the trees are green' is a concept.

There are various kinds of terms namely :—

(1) Singular and General
(2) Collective and Distributive
(3) Abstract and Concrete
(4) Ne ative and Positive
(5) Absolute and Relative
(6) Connotative and Denotative
(7) Categorematic and Syncategorematic
(8) Equivocal and Univocal

1. Singular and General Terms

A singular term is one which can be applied in the same sense to only a single thing or individual or an event. It can denote only one single object. All proper names are singular names since they refer to unique objects e.g. Kalidasa, Shakespeare, Madras, London, etc. In addition to the proper names, there are certain phrases or group of words which may indicate only one object e.g., the Governor of Madras, the death of Queen Victoria, 'What I said on that day' etc. Hence every singular name is restricted in meaning to a single instance or event. This is called a ***significant singular name.*** By prefixing, the, this, or that, general term becomes singular, because it limits the meaning to a definite object, e.g., that man, the book, this boy etc.

A general name is capable of being applied to a number of objects. It is a common name referring to a number of objects having certain common qualities e. g., book, tree, horse, motor, Governor of Bombay.

2. Collective and Distributive Terms

A collective term is a name applied to a group of things or persons. It refers to a number of individuals or things taken together and treated as a whole. The examples of collective names are army, library, regiment, committee etc. Collective names may be singular as 'the British Army in South Africa' 'the present House of Commons.'

We must distinguish a general name from a collective name. A general name applies equally to each individual of the group; in other words, it is used distributively. A collective name always

refers to a whole, or group. Thus soldier is a general name which is used distributively of each man in a regiment. All general names are distributive. Distributive terms are applicable in the same sense equally to anyone of an indefinite number of objects which resemble each other in certain qualities. Poet, plant, rope, motor etc., are distributive terms.

A name will be used either collectively or distributively. When we use a term collectively our assertion will only apply to a group or whole; when we use it distributively we assert something about each member of the group individually. In the proposition 'The stars give sufficient light for the travellers in the night'. 'Stars' is used collectively. The army was scattered. Here 'army' is used distributively.

3. Concrete and Abstract Terms

A concrete term denotes an object or thing having certain qualities such as desk, rope, cycle etc. All general names are concrete. A concrete name is the name of an object or thing viewed as possessing attributes; an abstract name is the name of an attribute, property or action considered apart from the object to which it belongs. Virtue, breadth, wisdom, justice, motion etc. are abstract names. An abstract name is the name of a quality considered by itself. A number of concrete names have their corresponding abstract names e.g., human, humanity, triangle, triangularity, red, redness. All adjectives are concrete names.

Sometimes the abstract name is also used as concrete. It becomes concrete when it is considered as a thing or objects having certain properties e.g., 'Warmth is agreeable. 'Warmth' is a concrete name because agreeableness is predicated of

it; in a word it is spoken of as a thing. So also when different kinds or degrees of an attribute are mentioned, as when we speak of moral courage, physical courage, the abstract name becomes concrete. Generally all the plurals of the abstract names are concrete like vices, nationalities, societies etc.

4. Positive and Negative Terms

A positive term is one which refers to the presence of any quality or qualities whereas a negative term refers to the absence of quality or qualities. The positive names are light, gratitude, agreeable, manly etc, and negative names are darkness, ingratitude, disagreeable, unmanly etc. Generally negative names are formed by prefixing in, un, dis, anti, im, non, mis etc, to the positive names. The negatives of auspicious, happy, honest, social, possible, transferable, conduct are inauspicious, unhappy dishonest, anti-social, impossible, non-transferable, misconduct. But these so-called negatives do not imply the exact opposite; hence in logic negatives are formed by prefixing 'not' or 'non' as not-happy. Sometimes words are positive in meaning though negative in form such as 'invaluable' 'unloosed etc; therefore negative prefixes are not safe guides.

Positive and negative names mutually exclude one another; they are called contradictories. 'Not happy' is the contradictory of happy; it is its exact opposite. A pair of opposites which does not exhaust between them the whole universe is called contraries. In other words contraries have middle ground whereas the contradictories have no middle ground. Hot and cold, wise and foolish, light and darkness are contraries. Hot and not-hot, wise and not-wise, light and not-light are contradictories. In the above examples of contraries, there is middle ground: between hot and cold there is warm,

between wise and foolish there is mediocre ability, between light and darkness there is twilight. But, between contradictories such as hot and not-hot there is no middle ground, not-hot means negation ot hot. It is not equivalent to 'warm'. Hence the logical contradictory is not the ordinary negative form but the form obtained by prefixing 'not' or 'non'.

But however it must be remembered that contradictory does not refer to the whole universe of existence. That is to say 'not white' does not denote whatever object in the world that is not white such as stones, desk, moon etc., Contradictories have limited sphere of reference, that is, it refers to the particular context to which it is applicable. 'Not-white' has reference only to the world of colour; not-sweet refers to the world of taste.

Generally a distinction is drawn between a negative term and a privative term. Privative terms refer to things which have not a quality, though they are capable of having it and normally have it, whereas negative terms are applied to things which have not and could not have had the quality. Words like 'blind' 'dumb' 'maimed' 'orphaned' etc., are privative terms. They are privatives because they refer to qualities which the objects to which they are applied naturally and usually have, but of which they have been deprived or which they have never possessed. Thus 'blind' is a privative term since it refers to the absence of eyes in a man which he naturally possesses.

5. Absolute and Relative Terms

An *absolute* term is the name of a thing or attribute, which has an intelligible meaning by itself and does not neccessarily refer to any other thing or attribute. A relative term is a name which derives its meaning only from its relation to something else

e.g., table, chair, dog, animal, etc. Relative terms refer either to the relation or relations between such objects, or the things which stand in that relation. Examples are father, cousin, better, west, similarity, equality etc. All the names of relations are relative terms e.g., symmetry, correspondence etc. The term 'parent' cannot be thought of except in relation to child. Relative terms usually go in pairs and are called *Correlatives*. Examples are: master and servant, king and subject, father and child etc.

6. Connotation and Denotation

Words are used to refer to things, to name and identify them. They have some meaning and also refer to some objects. They describe certain qualities or attributes and also apply to a number of objects which possess these attributes. The qualities which a word describes are called connotation, and its application to a number of objects is denotation. The connotation of a term indicates the qualities or attributes which it signifies and the denotation indicates the object. The word' man' has connotation that is it tells that 'man' has rationality, animality, etc., and also it has denotation, that is, it denotes a number of individuals such as Peter, Paul, John, etc. The connotation of 'carnivora' is the meaning of it. It means 'animals living on flesh'. Its denotation or application refers to seals, tigers, cats, wolves, etc. Connotation and denotation are also called respectively as intension and extension.

There are three views regarding the meaning of the word connotation. The first view is called *objective intension*. According to this view connotation means all the known and unknown attributes of a thing. In practice it is very difficult to know all the qualities or attributes of an object; hence this view is wrong. The second view is called *subjective intension*. According to this view the connotation

consists of those attributes which are associated with the name in the mind of any person who utters it. This view does not lay emphasis on the essential qualities, because the qualities may vary in different individuals. The third view is the correct ore. It is called '*conventional view*'. According to it connotation includes all those qualities that have been conventionally agreed upon as determining the application of them to any name. In other words connotatien is the essential qualities cf a thing.

A. Do Connotation and Denotation vary inversely?

We have seen that connotation means the attributes indicated by a name and denotation means individual objects denoted by it. Generally speaking the less is the connotation of a term, the more the denotation. For example, the term 'man' has certain connotation and its denotation refers to all the persons in the world. But when you increase the connotation by adding 'civilised', then denotation becomes less. Because it cannot be referred to all the people in the world. If we increase still more by adding 'educated' then denotation is enormously decreased. And conversely, by stripping off attributes, that is, by decreasing the intension, the number of individuals to which a term applies is increased. To take another example.

Ship
|
Steam Ship
|
Passenger Steamship
|
Oceans-going passenger steamship

In this case, as the connotation increases the denotation decreases. 'Ship' denotes a large number of

ships. 'Steamship' denotes ships only driven by steam. 'Passenger steam ship' denotes only such steamships which carry passengers and 'ocean-going passenger steam ship' denotes only such passenger steamships which go in the ocean. As the intension of a term is increased, its extension is diminished and *vice versa*.

The question arises as to whether this is always true. Do intension and extension vary inversely ? A very slight increase in intension may decrease the extension enormously. Thus add to 'books' the attribute bound; very little addition is made to the intension whereas extension is very greatly modified. Moreover, qualities cannot be measured mathematically. A single change in the connotation will result sometimes in a great and sometimes in a small change of denotation.

Further the connotation may be increased without any apparent loss of denotation, e.g., if we change 'man' to mortal man' or 'metal' to "elementary metal' these changes make no difference in the denotation ; for the property of mortality belongs to all men, and that of being an element to all metals. Similarly the increase in denotation might not modify connotation at all. Thus the connotation of man has not increased though there is an ever growing increase of population.

Hence the connotation and denotation do not vary inversely. As Bosanquet says "In any case it would not be right speak thus mathematically of an inverse ratio, because there is no meaning in a numerical comparison of attributes and individuals, and the addition of one attribute will exclude sometimes more and sometimes fewer individuals".

B. Mill's view of Connotation

Mill however makes a distinction between connotative and non-connotative names. He says 'a connotative term is one which denotes a subject and implies an attribute and a non-connotative term is one which signifies a subject only or an attribute only. John and London are non-connotative since they imply only a subject; whiteness, virtue, length are also non-connotative since they signify attributes only. According to this distinction concrete names are connotative and abstract and proper names are non-connotative.

C. Are proper names Connotative?

Every name has both connotation and denotation. But Mill says that proper names have no connotation. They denote the individuals that are called by those names; but they do not indicate or imply any attributes as belonging to those individuals. He calls them as 'unmeaning marks'. A man might have been called Armstrong, because in his youth he was strong in the arm; but if he grew weak, the name would not be taken from him. The 'Himalayas' is called by that name since there is ice on the mountains. Though by some volcanic change the ice may be removed, yet they will be called the Himalayas. A proper name stands for a concrete individual without any reference to attributes possessed in common with others. He treats the proper name as an 'unmeaning mark' given not to signify any qualities, but to identify an individual.

But Mills' view is wrong. Against this view, we maintain that proper names have also connotation. There is a sense in which the name Jones has connotation, even though it might not refer to a definite person. Thus the connotation of Jones, *when no particular person is meant, would be a name which*

is frequently employed to designate a human being. But it is true that the connotation of a proper name differs for every person, who happens to have it. The meaning of 'Rama' is one thing when it refers to the Ramayana and it is quite another when it refers to a student in a college. Consequently proper names have different denotation for each individual who is known by them. In other words, they have but one *single extension* because they are really singular names. This is one reason why they have been supposed to have no intension. To say that they have meaning is one thing, and to say that the meaning is general is quite another. In other words, a proper name has a meaning but it is not a general name.

A proper name as it stands in a proposition is usually sufficient to tell us (a) whether it implies a person or a place (b) to what nation or country he or it belongs and (c) if a person whether male or female. As Creighton says "when proper names are employed, the qualities or characteristics of the objects named, are indirectly implied". Then, a proper name has a meaning, but not general in scope.Hence we conclude in the words of Bosanquet that a proper name has a *connotation* but not a *fixed general connotation.*

D. Are abstract names non-connotative?

According to Mill, abstract names are non-connotative. But in fact every term has both extension and intension. It is quite clear that abstract names are true of particular instances e.g., virtue has extension in as much as it refers to different kinds of virtues such as courage, temperance, etc. and its intension is that it means some ethical quality. Thus the term 'insanity' has a connotation i.e., it is a diseased state of mind and it

has a denotation i.e., it refers to 'mania', 'monomania' 'dementia'. Hence we conclude abstract names are both connotative and denotative.

7. Categorematic and Syncategorematic

Names are divided into categorematic and syncategorematic. A categorematic word is one which can be used *alone*, either as the subject or predicate of a proposition. A syncategorematic word is one which can only form a part of a name, as infinitives, prepositions, adverbs, articles, interjections, conjunctions etc. Iron is heavy. Here 'iron' and 'heavy' are categorematic. *The* sun is a hot sphere. 'The' is syncategorematic. Sometimes, even a syncategorematic word may be used as categorematic, as 'The' is an article, 'To err' is human etc.

8. Univocal and Equivocal

An equivocal term is one having different meanings, e.g., sovereign may mean a coin or a king. A univocal term is one having only one meaning, e.g., father, nitrogen etc.

VARIOUS EXERCISES WORKED OUT.

I. Give the logical characteristics of the *italicised* terms in the following propositions:—

1. *The Madras University* is a very old one. Ans.—Categorematic, univocal, collective, singular, concrete connotative, positive and absolute.

2. Homer was *blind*. Ans.—Categorematic, univocal, general, concrete, privative, absolute, distributive, connotative.

3. *Colleges* are centres of learning. Ans.—Categorematic, univocal, general, distributive, concrete, positive, absolute and connotative.

4. *This mob* is very unruly. Ans.—Categorematic, univocal, singular, collective, concrete, positive, absolute and connotative.

5. *Mobs* are gatherings of people. Ans.—Categorematic, univocal, general, distributive, concrete, positive, absolute and connotative.

6. *The boy with whom you have spoken* is a rogue. Ans.—Categorematic, univocal, singular, distributive concrete, positive, absolute and connotative.

7. *The earthquake of India in 1934* was very disastrous. Ans.—Categorematic, univocal, singular, distributive, concrete, positive, absolute and connotative.

8. *Anything that you may talk* will be unintelligible to me. Ans.—Categorematic, univocal, general, distributive, concrete, positive, absolute and connotative.

9. Krishnan is a *solomon* of the class. Ans.—Categorematic, univocal, general, distributive, concrete, positive, absolute and connotative.

10. *The Italians* are musical. Ans.—Categorematic, univocal, general, collective, concrete, positive, absolute and connotative.

11. John went *to* the hospital.—Ans. Syncategorematic.

12. I remember *what I have read*. Ans.—Categorematic, univocal, singular, collective, concrete, positive, absolute and connotative.

13. *All the works of Shakespeare* cannot be read in a day. Ans.—Categorematic, univocal, singular, collective, concrete, positive, absolute and connotative.

14. This poem has *the Miltonic grandeur*. Ans.—Categorematic, univocal, singular, distributive, concrete, positive, absolute and connotative.

15. John is a *King of England and France*. Ans.—Categorematic, univocal, general, distributive, concrete, positive, absolute and connotative.

16. The *jury* were divided in their opinion. Ans.—Categorematic, univocal, distributive, concrete, positive, absolute and connotative.

17. The *hatefulness* of Mr. Hyde is a haunting horror. Ans.—Categorematic, univocal, general, distributive, concrete, positive, absolute and connotative.

18. *Hatred* is a vice. Ans.—Categorematic, univocal, general, distributive, abstract, positive, absolute and non-connotative.

19. All *regiments* are ready for action. Ans.—Categorematic, univocal, general, distributive, concrete, positive, absolute and connotative.

20. *One and three* are four. Ans.—Categorematic, univocal, general, collective, concrete, positive, absolute and connotative.

II. State the logical characteristics of the following:—

The Renaissance, lame, equation, nationality, invaluable, alien and imparadise.

The Renaissance:—Categorematic, univocal, singular, collective, concrete, positive, absolute and connotative.

Lame:—Categorematic, univocal, general, distributive, concrete, privative, absolute and connotative.

Equation:—Categorematic, univocal, general distributive, concrete, positive, relative and connotative.

Nationality:—Categorematic, univocal, general collective, positive, absolute and connotative.

Invaluable:—Categorematic, univocal, general, distributive, concrete, positive, absolute and connotative.

Alien:—Categorematic, univocal, general distributive, concrete, negative, absolute and connotative.

Imparadise:—Categorematic, univocal, general, distributive, concrete, positive, absolute and connotative.

EXERCISE II.

I. State the logical characteristics of the *italicised* terms in the following propositions:—

(a) *Two wrongs* do not make a right.

(b) *All the fish* were caught in Loch Lomond.

(c) *All the fish* weighed twenty pounds.

(d) *Unpunctuality* is irritating.

(e) *The Hindus* are spiritualistic.

II. Give the logical characteristics of the following terms:—

Pound, Pulses, Impoverishment, Milton's Poetical Works, Sivasamudram Waterfalls, The United Provinces of Agrah and Oudh, Dancing Party, Unloosed,

Reformation. A Kambar, A Peddanna, Shakespearian Grammar, Organism, Inequality, Deduction, Correspondence, Identity.

III. "Connotation and denotation vary inversely" Discuss.

IV. Are proper names connotative?

V. Are abstract names connotative?

VI. What different senses have logicians attached to the expression—the intension of a name? Are there any names which simply denote objects without giving any information about the characteristics of those objects?

VII. Write short notes on:—

Significant Singular; Privative; Contrary; Universe of Discourse and Correlatives.

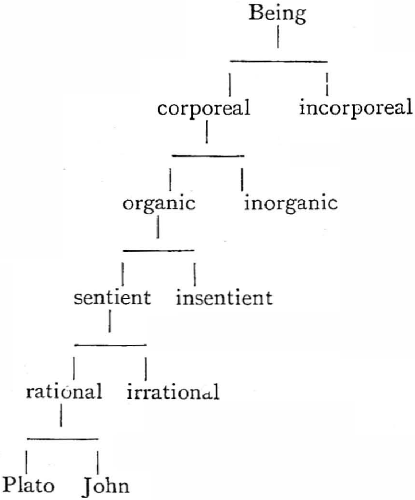
VIII. Distinguish a term from a name and a concept.

CHAPTER III

PREDICABLES

1. Tree of classification

We have seen already that if connotation increases, denotation decreases and *vice versa*. Here every term is regarded as a class including a sub-class. Thus e.g., the class 'carnivora' includes the sub-classes 'lions' 'tigers' 'cats' 'wolves' etc. One class is said to be more general than the other, when the individuals falling under the one are greater in number than the other. The class 'mammalia' is more general than 'man'; and the class 'animal' is still more general than 'mammalia'. A 'genus' (*samanya*) is a class which includes two or more subordinate classes or species (*visesha*). A species is simply a sub-division or a subordinate class of some larger class. Thus 'mathematics' is a genus which has a number of species such as arithmetic, algebra, geometry calculus, trigonometry etc. But it must be remembered however that genus and species are relative. That is, any term may be considered either as a species or a genus, according as it is regarded as forming part of some more comprehensive class, or as itself including other classes. Thus the term 'mathematics' can be regarded as either a genus or a species. If mathematics is regarded as a class including species such as arithmetic, algebra, geometry etc., then it is said to be a genus. If mathematics is itself considered to be a sub-class of the genus 'science' then it is a species. Hence we can arrange classes in ascending or descending orders of increased denotation. The following is called the Porphyry's Tree of Classification.



In this series we have an increasing degree of connotation as we go down from one class to another sub-class. If a class is such that a more general one cannot be found, then it is called summum genus (*sattasamanya*). If a class is such that a less general one cannot be found except the composing individuals, then it is called infima species *(antyavisesha).* The intermediate classes between summun genus and infima species are called subaltern genera. The genus next above a particular species is called proximum genus. In the Porphyry's Tree,' Being' is summum genus, 'rational' is infima species 'corporeal' 'organic', 'sentient' are subaltern genera. The proximate genus of 'organic' is 'corporeal'.

2. Predicables

A predicable is that which is affirmed or denied of the subject[2] in a proposition. In other words, it indicates the relation which a predicate bears to its subject. Predicables are five in number viz., genus, species, differentia, proprium, and accidens.

a. *Genus.* Genus is a class which has some sub-classes called species e.g., Carnivora is a genus having the species like, tigers, lions, cats etc. The following predicates belong to the predicable called genus, e.g. Man is an animal. Triangle is a rectilineal figure.

b. *Species.* Species is a sub-class which belongs to a genus, e.g., 'tigers' is a species of the genus 'Felidae', 'triangle' is a species of rectilineal figure. Thus species are sub-classes or subordinate classes of any genus.

c. *Differentia.* Differentia is the specific quality which differentiates one species from the rest in the same genus, e.g., rationality is the differentia which marks off man from the rest of the species in the genus 'animal'.

d. *Proprium.* Proprium is a property which belongs to the whole of a class and is peculiar to it. It is an inseparable quality. Properties of an object can be reduced or inferred from the essential characteristics of it. Liquids finding their own level is a property of them.

e *Accidens.* Accidens is neither an essential attribute nor a property of a thing. It is an accidental feature of an object which may or may not belong to all the individuals of a class. There are two kinds of accident. (1) separable and (2) inseparable. A separable accident may belong to an individual at one time and not at another. It does

not belong always to an object e.g., John is standing on the road, Gandhi is addressing the Harijans. An inseparable accident is that which belongs to a thing always; it cannot be separated from the object. The blackness of a crow is an inseparable accident because it cannot be separated from it.

EXERCISES WORKED OUT.

1. To which of the predicables does each of the following predicates belong?

(a) Even men are animals. Ans.—The predicate "animals" belongs to the predicable called genus.

(b) Logic is a good mental discipline. Ans.—The predicate "good mental discipline" belongs to the predicable called property,

(c) The Englishmen are keen sportsmen. Ans.—The quality "keen sportsmen" is a separable accident of the Englishmen.

(d) Certain animals hibernate. Ans.—The quality "hibernation" is a property of certain animals.

(e) A proper fraction is one whose numerator is less than its denominator. Ans.—The predicate in this proposition is a property of the proper fraction.

(f) Gandhi is a great social reformer. Ans.—The predicate "a great social reformer" is a separable accident of Gandhi.

(g) Birds are feathered. Ans.—"Feathered" is an inseparable accident of birds.

(h) Man is a laughing animal. Ans.—The predicate "laughing animal" is a property of humanity.

(i) All negroes are woolly-haired. Ans.-The quality "woolly haired" is an inseparable accident.

(j) Yellow phosphorous takes fire when exposed to air.

(k) Iodine volatalises. Ans.-In the above two examples the predicate is a property.

(l) Bose is lecturing to his students. Ans.-Here the predicate 'lecturing to his students' is a separable accident of Bose.

(m) Sir C. V Raman is born in South India Ans— The predicate "born in South India" is an inseparable accident of Sir C. V. Raman.

Note. All the properties of number, physical objects like gases, sound, force, metals etc., belong to the predicable called property. Inseparable accidents are the date, andthe place of a man's birth. The man's professions, dress, manners, postures, acts etc. are separable accidents

EXERCISE III.

I. To which of the predicables does each of the following predicates belong ?

1. All the angles of a square are equal.
2. All the republics are government.
3. The tiger is a predatory animal.
4. Tom Jones is very ill.
5. A straight line is the shortest distance between two points.
6. Gold is heavy.
7. Darwin formulated the theory of evolution.
8. Milton was blind.
9. Shakespeare wrote *Hamlet*.
10. John was born in June 2nd 1909.
11. The Moon has mountains.
12. Water is a combination of hydrogen and oxygen.
13. A living being is nothing but a combination of chemical elements.

II. Write short notes on :—

1. Predicables, 2. Summum genus, 3. Infima species.

CHAPTER IV

DEFINITION AND DIVISION.

1. Definition.

Definition *(lakshana)* of a term states its connotation or essential attributes. It is different from *description.* Description gives only an outside view of things and catches what is more apparent to the senses. But the definition is the result of accurate analysis and pains-taking investigation. Description gives us an imaginative picture of an object in words. Generally a distinction is drawn between *verbal* and *real* definition. A verbal definition is nothing but an explanation of any given term; in short it is expounding the meaning of a particular word. "Monarchy consists in the authority of one man over others" is an example of verbal definition. But when it is the purpose of our assertion to state the real nature or essential characteristics of some objects, then it is a definition.

RULES OF DEFINITION.

1. A definition should state the essential attributes of a thing to be defined. A logical definition should give the next or proximate genus and the differentia of the species to be defined. In other words we must give the proximate genus to which a particular term refers and then add to it the specific feature which differentiates it from the rest of the species of the same genus. Thus we define a traingle as a rectilinear figure (genus) having three sides. (Differentia). Man is a rational (differentia) animal (genus). This kind of definition is technically called "definition per genus et differentiam".

2. A definition should not contain the name to be defined nor any word which is directly synonymous with it. The following definition violates this rule. Justice is the way of acting justly. This fallacy is technically called *circulus in definiendo* (circular definition.)

3. The definition should be exactly equivalent to the class of objects defined. It must be neither too wide nor too narrow. A definition which states more than the connotation of the term defined is too narrow, because it includes qualities which are not essential and therefore suggests that the definition of a term is less than it would be if these qualities were not included in the definition. To define man as an animal who cooks food is to have a narrow definition, because the accidental feature of his cooking food suggests as though that the definition is less than what it would be if these qualities are omitted.

Similarly a definition which states less than the connotation of a term is too wide; evidently it consists of either the genus or differentia each of which is wider than the term defined e.g., Cow is a quadruped. Further a definition of a higher class by a lower class is a narrow definition e.g., A vertebrate animal is a quadruped. The fallacies of too wide and too narrow are called respectively in Indian logic as *ativyapti* and *avyapti*.

4. A definition should not be expressed in obscure, figurative or ambiguous language. The violation of this rule involves the fallacy called "ignotum per ignotius" (unknown by the more unknown), e.g., Network is anything reticulated or decussated at equal distances with interstices between the intersections. A periphrasis is a circumlocutory cycle of oratorical sonorasity, circumscribing an atom of ideality, lost in verbal profundity. A girl is an

oval mass of bent space being thrown off like electrons from swiftly rotating nihlowatts with all the speed of idiol (Einstein).

5. A definition should, wherever possible, be affirmative rather than negative. In other words a definition should state what a term implies rather what it does not imply e.g., 'Liquid is a substance which is neither a solid nor a gas is a negative definition.

LIMITS OF DEFINITION.

Proper names cannot be defined. Names of simple sensations such as sensation of white cannot be defined. The terms like space, time, life etc., cannot be defined since we cannot refer them to any higher class. The summum genus cannot be defined.

GENETIC DEFINITION.

Genetic definition shows us the way in which thing is generated. This kind of definition states how a particular object is caused or produced, e.g., a sphere is a solid figure formed by the revolution of a semicircle about its diameter which remains fixed; water is formed out of hydrogen and oxygen.

DIAGNOSTIC DEFINITION.

In biology this kind of definition is very common. Diagnostic definition states the genus of any plant or animal with the characteristic marks of the species by which it can be recognised, e.g., to define a horse the biologist will merely enumerate its characteristics.

2. Division.

Logical division is dividing a class into a number of sub-classes. If we divide animals into by bipeds and quadrupeds, it is a logical division. It must be distinguished from the following:

PHYSICAL DIVISION.

This is nothing but physical partition by which objects are split into their component parts, eg.

the breaking of a chair into a number of parts is a physical division.

METAPHYSICAL DIVISION.

This is an abstracting process of the intellect. When the qualities or attributes of an object are abstracted severally, it is a metaphysical division e.g., if the colour, size, shape etc., of a chalk are considered separately we get the metaphysical division of chalk.

VERBAL ANALYSIS.

If we distinguish different meanings of a word then it is a verbal analysis e.g., light may mean either the opposite of darkness or the opposite of heavy.

If we divide the rectilineal figure into triangle, quadrilateral and polygon, the number of sides is the basis or principle on which the division is made. Such a principle of division is called *fundamentum divisionis*; the genus thus divided is called *totum-divisium*, and the divided members are called *membra dividentia*. The same genus may be divided on different principles into several sub-classes, e.g., Triangles can be divided into equilateral, isosceles and scalene on the basis of their relative length of the sides; and they can also be divided into acute-angled triangle, obtuse-angled triangle and right-angled triangle on the basis of the magnitude of angles. This kind of division of a term on the basis of two or more principles is called a co-division.

RULES OF DIVISION.

1. Every division must be based on a single principle.

2. The constituent species must not overlap, but must be mutually exclusive.

3. The division must be exhaustive i.e., the constituent species must be equal, when added together to the genus.

4. If the division includes a number of subdivisions, each step must be as for as possible a proximate one. It must not make a leap.

EXPLANATION.

The first rule simply states that there must be only one fundamentum divisionis in a division. If there is more than one principle the result is a cross-division e.g., If we divide men into Europeans and Hindus and Asiatics, there are two principles involved here, namely geographical distribution and religion. The second rule indicates that the constituent species must be mutually exclusive, that is they must not overlap. In a cross-division, the sub-classes overlap since there is more than one principle. The third rule states that the division must be exhaustive; all the species must be enumerated. If we divide men into Hindus, Christians and Mohammedans the division is not exhaustive since there are people belonging to other creeds not listed above. The fourth rule tells that division must proceed step by step. It must not make jumps. If we have division like the following we violate the this rule.

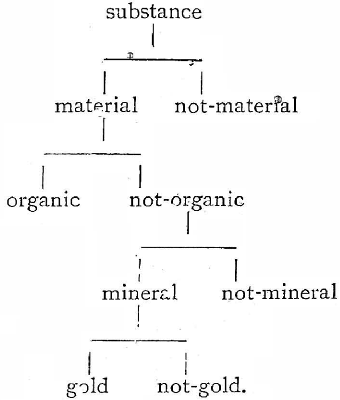
Men

Hindus Vaishnavites Christians

DIVISION BY DICHOTOMY.

It is very difficult to have a division where there is exhaustive enumeration of species. The ideal division is based on the principle of dichotomy. It depends upon the logical nature of contradictories;

if 'a' is divided into 'a' and 'not-a', 'not-a' is the contradictory of 'a', and necessarily it excludes 'a' hence there is no middle ground between 'a' and 'not-a'. This is called the division based on the principle of dichotomy.



3. The Relation between Definition and Division

Definition and division refer to the intension and extension of a term respectively. In other words, definition merely states the connotation of a term. Division classifies the individuals into various classes and sub-classes.

4. Classification.

Classification is a series of divisions and sub-divisions. In scientific classification various objects are grouped together according to their affinity. The things are classed together when they resemble one another in a definite quality or group of

qualities. Thus the animals are divided into two classes, vertebrates and invertebrates—vertebrates are animals having vertebral column and invertebrates are those having no vertebral column. The common qualities that determine a class must be essential. It must not be based on superficial resemblances or likenesses.

There are two kinds of classification viz., natural and artificial. Natural classification is based on those qualities that are found in a large number of objects. In other words it is based on fundamental features e.g., the division of animals into vertebrates and invertebrates is a natural classification. An artificial classification is based on some arbitrary principle. The alphabetical arrangement of words found in a dictionary is an artificial classification.

TERMINOLOGY.

Terminology is a collection of technical names which are used to describe the various features of an object accurately. In botany we have different names like the following obate, lanceolate, elliptical, rhomboidal, etc., to describe the different shapes of leaves.

NOMENCLATURE.

A nomenclature is a system of names for the groups of objects, for example, the vertebrate animals are divided into mammals, birds, reptiles, batrachians, fishes etc. Nomenclature indicates the names given to the various groups.

VARIOUS EXERCISES WORKED OUT.

I. Criticise the following definitions :—

1. A church is a building used for ecclesiastical purposes.

Criticism.—This is a synonymous definition. In this case, ecclesiastical is a Latin adjective of church. It commits the fallacy called 'Circulus in definiendo'

2. A cow is a horned ruminant.

Criticism.—This is a narrow definition because the accidental feature 'horned' is added to the genus 'ruminant'

Note:—A definition becomes narrow if an accidental feature or property is added to the genus.

3. A blackleg is a workman who is not a member of a trade-union.

Criticism.—This definition is wrong because it is stated in a negative form.

4. Prudence is the ballast of the moral vessel.

Criticism.—This is a figurative definition and hence it is wrong. It commits the falalcy of 'ignotum per ignotious.'

5. Man is a laughing animal.

Criticism.—This is a narrow definition because the accidental feature 'laughing' is added to the genus 'animal'.

6. The base of a triangle is the side opposite the vertes.

Criticism.—This is a negative definition.

7. A university is an educational institution.

Criticism.—This is a verbal definition because only the meaning of the term is stated in the definition.

8. Virtue is acting virtuously.

Criticism.—This is a wrong definition; the fallacy it commits is called 'circulus in definiendo.'

9. Noon is the time when the shadows of bodies are shortest.

Criticism.—This is a narrow definition because the property 'the shadows being shortest' is added to the genus 'time'.

10. Man is a featherless biped.

Criticism.—This is also a narrow definition because the accidental feature 'featherless' is added to the genus. This is also a negative definition.

11. Life is the opposite of death.

12. Peace is the absence of war.

13. A gentlemen is a man who has no visible means of subsistence.

14. Wisdom is the avoidance of folly.

15. A utilitarian is one who does not believe in an intuitional basis of morals.

16. A moral man is a man who does not lie or steal or live intemperately.

17. Liquid is that which is neither a solid nor a gas.

18. Sleeping is the opposite of waking.

Criticism.—The above eight definitions are negative; therefore they are wrong.

19. Music is expensive noise.

20. Time is the moving image of eternity.

21. Prayer is the sincere desire of soul.

22. Work is is the salt of life.

23. Network is a reticulated system of cordage.

24. The body is the emblem or visible garment of soul.

25. Thunderbolts are the winged messengers of gods.

26. Humour is oil and wine of merry meeting.

27. Memory is the tablet of mind.

28. Justice is the health of soul.

29. Duration is a temporal slab of nature.

30. Rust is the red desquamation of iron.

31. Fluency is an exuberance of velocity.

32. Procrastination is the thief of time.

Criticism.—The above fourteen examples are stated in figurative and obscure language, hence they are fallacious.

33. A chair is an article of furniture with four legs and a back.

34. A candle is a kind of light used before gas was invented.

35. A soldier is a brave man who is ready to die for his country.

36. The sun is a star that shines by day.

37. A kitten is a playful creature which runs after balls of wool.

38. A shrub is a plant which is about two feet in height.

Critcism.—The above six are narrow definitions since accidental attributes are added to them.

39. A horse is a quadruped.

40. Man is a vertebrate animal.

41. Rock is a substance.

42. Man is a self-conscious being.

Criticism.—The above four definitions are too wide because the genus alone is stated.

43. A power is a force which tends to produce motion.

44. Orthodoxy is my doxy; heterodoxy is another man's doxy.

45. Vestigial characters in animals are the remnants of the past adaptation.

Criticism.—The above three definitions are circular definitions because they contain the synonym of the words defined.

46. Water is a combination of hydrogen and oxygen.

47. Sound sensations are those which are produced by the stimulation of the auditory nerve.

48. Belief is the consequence of an indissoluble association of ideas.

Criticism.— The above three definitions are *genetic* definitions because they state the manner in which a thing is produced.

II. Criticise the following divisions:—

1. Men into imaginative and unimaginative.

2. Plants into poisonous and non-poisonous.

3. Indians into Hindus, Christians, Jains and Saivites.

4. Pictures into historical, sacred, mythological, landscape and comic.

5. Chair into legs, back and seat.

6. Men into Mongolians, African, white and red.

7. The division of members of Madras Legislative Council into non-officials, swarjists, and justicites.

8. India into Madras Presidency, Mysore, Hyderabad, Coorg

9. Lemonade into sweetness, sourness etc.

10. Religions into monotheism, polytheism, Buddhism and Christianity.

Criticism.—

1. This division is not exhaustive.

2. This is a division by *dichotomy.*

3. The division is not made step by step e.g., 'Saivites' is a sub-division of Hindus.

4. This is not an exhaustive division.

5. This is a physical division because various component parts of it are enumerated.

6. This is a cross division because it involves two principles (1) geographical distribution (2) complexion.

7. This involves two principles of division. (1) party to which a member belongs (2) ex-officio and non--exofficio.

8. This is a physical division.

9. This is a *metaphysical analysis.*

10. The division is not made step by step. Buddhism and Christianity are sub-divisions of monotheism.

EXERCISE IV.

I. Write short notes on:—Genetic definition, cross division, co-division, nomenclature and terminology.

II. What is the difference between a natural and an artificial classification.

III. Consider carefully the relation of definition to (a) description, and (b) division.

IV. Criticise the following divisions :—

(1) Men into civilised, tall, honest and clergymen

(2) Students into men, women, research, undergraduates.

(3) Non-Brahmins into Nayudus, Mudaliars, Chetties and Naickers.

(4) Religions into Christianity, Hinduism, Jainism, Roman Catholicism and Puritanism.

(5) North America into U.S.A., Canada, Mexico.

(6) Human body into head, hands, legs.

(7) Apple into sweetness, smoothness, rotundity.

(8) Grammar into syntax and prosody.

(9) Pens into steel pens and quill pens.

(10) Season tickets into transferable and non-transferable.

V. Criticise the following definitions :—

1. Tin is a metal lighter than gold.

2. Reverence is the feeling produced by the recognition of worth or superiority in others.

3. A straight line is that which lies evenly between its extreme points.

4. Chance is the cause of fortuitous events.

5. Man is a human being.

6. A plumber is a man was. is usually assisted by plumber's boys.

7. A judge is a lawyer who excercises judicial functions.

8. Truth is veracity in speech and action.

9, Tranquillity is the absence of unrest.

10. A Council is a deliberative body.

11. A girl is a perpendicular biological phenomenon in short skirts.

12. Rice is an article which is used as food in India.

13. Coins are lumps of metal.

14. Flour is something used in cooking.

15. A plant is an organic being possessing vegetable life.

16. A spoon is a concave vessel with a handle used is drinking liquids.

17. An eclipse in an obscuration of luminaries.

18. An interrogative sentence is one which does not state a fact, entreaty, command or exclamation.

19: A disease is an unhealthy condition of body or mind, having hurtful or fatal consequences.

20. Virtue is that line of conduct which tends to produce happiness.

CHAPTER V.

PROPOSITIONS.

1. The Nature of Proposition

A proposition is that which affirms something of something else. All sentences except wishes, exclamations and interrogations are propositions. A proposition can be divided into subject' predicate, and copula, e.g., Gold is yellow, 'Gold' is subject 'is' copula 'yellow' predicate.

2. The Quality and Quantity of propositions

According to *quality*, the propositions are divided into affirmative and negative.. An affirmative proposition is one in which an agreement is affirmed between subject and predicate or in which predicate is asserted of subject e.g., snow is white. A negative proposition indicates a lack of agreement or harmony between the subject and predicate e.g., weather is not fine.

According to quantity the propositions are divided into *universal* and *particular*. When the proposition refers to all the individuals denoted by the subject, it is said to be universal e.g., All metals are elements. If, on the other hand, the proposition affirms that the predicate belongs to only a part of a subject, it is said to be *particular* e.g., Some men are black.

Universal	affirmative	All S is P	A
,,	negative	No S is P	E
Particular	affirmative	Some S is P	I
,,	negative	Some S is P not P	O

3. Import of propositions

By import of propositions we mean the relation which exists between the subject and predicate of a proposition. There are four interpretations given to the import of propositions namely, (1) predicative view, (2) class-inclusion view, (3) attributive view and (4) connotative-denotative view.

(a) PREDICATIVE VIEW.

According to this view the proposition expresses the relation of a subject and an attribute. The subject denotes a thing or an object and the predicate signifies certain qualities which are predicated of it e.g., All men are mortal; here, mortality is an attribute affirmed of the individual man.

(b) THE CLASS-INCLUSION VIEW.

According to this view the subject and predicate are both read in denotation; the proposition is held to assert that the class denoted by the subject is included in or excluded from the class denoted by the predicate. In the example, 'all men are mortal', the class denoted by 'men' is included in the class denoted by 'mortal'. The diagrammatic representation of propositions is based on this view.

(c) ATTRIBUTIVE VIEW.

According to this view both the subject and predicate are read in connotation. All men are mortal. This can be expressed thus: whatever has the attribute humanity has the attribute mortality; or mortality always accompanies the attribute humanity.

(d) THE CONNOTATIVE-DENOTATIVE VIEW.

According to this view, the subject is read in connotation and the predicate in denotation. 'All men are mortal' can be interpreted thus: the

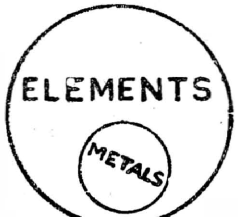
attributes signified by humanity indicate the presence of an object belonging to the class 'mortal beings'.

4. Diagrammatic representation of propositions.

We have seen already that the diagrammatic representation is based on the class view of propositions. Hence the subject and predicate terms are to be considered as classes. If something is affirmed of all the individuals of a class, then it is said to be distributed; if the assertion is made of a limited number of the individuals of a class, then it is said to be undistributed. In other words, a term is said to be distributed when the whole extent is referred to; it is said to be undistributed when reference is made only to a part of its extent.

The meaning of the four propositions A, E, I and O can be represented by means of diagrams called the Euler's circles.

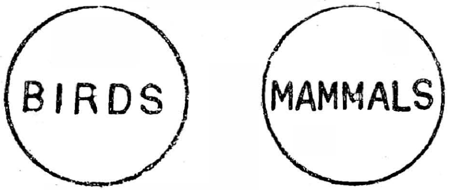
'All metals are elements' is an 'A' proposition. To represent the above one, we draw a circle to symbolise the class of 'elements', and then place inside it a smaller circle to stand for 'metals'.



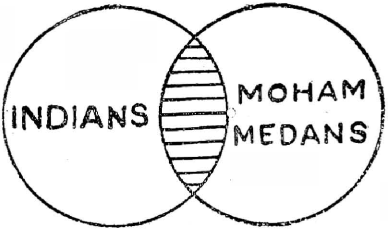
It must be noted that A proposition does not usually assert anything of the whole of its predicate. Therefore the predicate is undistributed.

The subject is distributed since it is employed in its fullest extent.

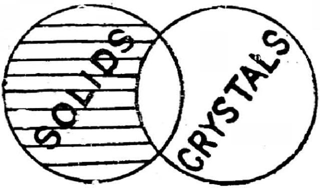
In an 'E' proposition the subject and predicate are completely excluded, e.g., No bird is a mammal. Both the subject and predicate are distributed: the representation is as follows.



In an 'I' proposition, both the subject and predicate are employed in a limited extent. In other words, both of them are undistributed, e,g, some Indians are Mohammedans. The representation is as follows.



In an 'O' proposition, the subject is not distributed and the predicate alone is distributed e.g., some solids are not crystals. This may be represented as follows.



Here the shaded portion symbolising, 'some solids' falls completely outside the circle of 'crystals'. Hence the subject is undistributed and the predicate distributed.

We shall summarise our results thus:

A	Subject	distributed,	predicate	undistributed.
E	,,	,,	,,	distributed.
I	,,	undistributed	,,	undistributed.
O	,,	,,	,,	distributed.

VARIOUS EXERCISES WORKED OUT.

1. A little knowledge is a dangerous thing.

L. F. All cases of having little knowledge are cases of being dangerous things.

Note. Scientific laws, proverbs, etc., must be reduced to 'A' proposition.

2. Fine feathers do not make fine birds.

This is an *indesignate proposition.* This must be reduced to 'O' since it is negative.

L. F. Some cases of having fine feathers are not cases of being fine birds.

3. Not all who are called are chosen

L. F. Some people who are called 'are-not' persons chosen.

Note. If any proposition contains 'not all' it must be reduced to 'O'.

4. The more the merrier.

L. F. All new-comers are mirth-increasers 'A'.

5. All but a few are taken prisoners.

This is an *exceptive* proposition where the exception is not definitely specified.

L. F. Some persons are those who are taken prisoners.

6. All metals except mercury are solids.

Since the exception is definitely specified it must be reduced to 'A' proposition.

L. F. All metals except mercury are solids.

7. Every man is liable to error.

L. F. All men are persons liable to error.

Note. All propositions beginning with 'all', 'every', 'each', 'any' without the sign of negation must be reduced to 'A' proposition.

8. All that glitters is not gold.

L. F. Some objects that glitter are not gold.

Note. All propositions begininning with 'all' 'every', 'each', 'any' with the sign of negation must be reduced to 'O' proposition.

9. Most of the students have passed in logic.

L. F. Some of the students are persons who have passed in logic.

Note. All propositions commencing with 'most', 'a few', 'many,' 'almost all,' 'but one,' 'a little', 'a,' 'one, 'half,' 'a portion,' etc, must be reduced to 'I' proposition.

10. Students sometimes make mistakes.

L. F. Some students are persons who make mistakes.

Note. All propositions containing such words 'mostly,' 'generally,' 'frequently,' 'often,' 'perhaps,' 'nearly always,' 'sometimes,' etc., should be treated as particular; if there is a sign gf negation in such propositions they must be reduced to 'O'

11. Few men succeed in life.

L. F. Some people are not persons who succeed in life.

Note. 'The propositions having 'few,' 'little,' must be reduced to 'O'; but propositions containing 'a few' 'a little' must be reduced to 'I'

12. People seldom overcome their temptations.

L. F. Some people are not persons who overcome their temptations.

Note. The proposition having the words 'seldom, scarcely', 'hardly,' must be reduced to 'O' proposition

13. Only the graduates are eligible.

This is an *exclusive proposition*; hence it can be reduced to any one of the following forms.

L. F. (a) All those who are eligible are graduates.

(b) No non-graduate is eligible.

14. None but the brave deserve the fair.

L. F.(a) All those who deserve the fair are brave people.

(b) No not-brave is a person who deserves the fair.

Note. The propositions having 'only,' 'alone,' must be reduced to either A or E as in the above.

15. Faint heart never won a fair lady.

L. F. No man having a faint heart is a person who won a fair lady.

16. Any excuse will not suffice.

L. F. No excuse is a thing that will suffice.

Note. If there is the word 'any' in any proposition it must be reduced either to A or E.

17. It does not always rain.

L. F. Some days are rainy.

18. Few, save the poor, feel for the poor.

L. F. All those who feel for the poor are poor people.

I. Reduce the following to the strict logical form:-

1. Not every tale is to be believed.
2. Few men are acquainted with themselves.
3. Only the honest are respected.
4. One swallow does not make a summer.
5. He always succeeded.
6. Any one can do that.
7. All men are not doctors.
8. It is never too late to mend.
9. Only the ignorant affect to despise knowledge
10. One man in his time plays many parts.
11. Our sincerest laughter with some pain is fraught.
12. Socrates declared knowledge to be virtue.

13. Only the ignorant persons hold such opinions.
14. General notions are generally wrong.
15. Heat and work are mutually convertible.
16. We cannot all do all things.
17. Only the educated are fit to vote.
18. No man can be rich and happy, unless he is also prudent and temperate, and not always then.
19, All is lost but honour.
20. All except seven were saved.
21. A few workmen are the only survivors.
22. Tress-passers are not always prosecuted.
23. Only the Protestant princes can sit upon the throne of England.
24. No one is admitted except on business.
25. It cannot be that none would fail.
26. Unasked advice is seldom acceptable.
2.7 There is none righteous, no not one.
28. It never rains but pours.
29. On the hill side deep lies the snow.
30. Many hands make light work.
31. The hands of the people of Glasgow are many.
33. Many rules of grammar overload the memory.
33. The fewer the better.

II. Give a brief account of the import of propositions.

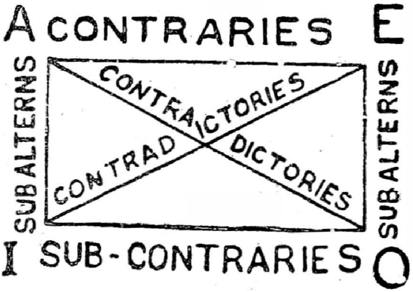
III. Write short notes on:—

Euler's Circles., Distribution of terms.

CHAPTER VI

THE OPPOSITION OF PROPOSITIONS.

Two propositions with the same subject and predicate but with difference in quality or quantity or in both, are technically called to be opposed to each other. Opposition may be defined as the relation of four propositions to each other, as regards the truth or falsity, when they have the same subject and predicate. These relations are represented by means of a diagram called 'the square of opposition'.



A and E are known as contraries; I and O as sub-contraries; A and I, E and O as subalterns.

(1). Of contrary propositions, if one is true the other is false, but both may be false. And both cannot be true.

(2) Of contradictory propositions, if one is true, the other must be false.

(3) If a universal proposition is true, the particular which stands under it is also true. But if the universal is false, the particular may or may not be false.

(4) If a particular proposition is true, the corresponding universal may or may not be true; but if the particular is false, the universal must also be false.

(5) Sub-contraries may both be true; but if one is false, the other must be true. And both cannot be false.

We have already seen that the truth or falsity of one involves the truth or falsity of the other. We shall summarise the results thus :—

If A is true, E is false, I is true, O is false

If A is false, E is doubtful, I is doubtful, O is true

If E is true, A is false, I is false, O is true

If E is false, A is doubtful, I is true, O is doubtful

If I is true, A is doubtful, E is false, O is doubtful

If I is false, A is false, E is true, O is true

If O is true, A is false, E is doubtful, I is doubtful

If O is false, A is true, I is true, E is false

VARIOUS EXERCISES WORKED OUT.

I. Give the contrary (or sub-contrary) and contradictory of the following of propositions :—

1. All metals are elements.
2. No coward need apply.
3. Socrates was the wisest man in Athens.
4. Not all men are brave.
5. No man but a traitor would have done this.

Ans.—

1. All metals are elements (original proposition).

No metals are elements (contrary).

Some metals are not elements (contradictory).

2. No coward need apply (original proposition).

L. F. No. coward is a person who need apply.

All cowards are persons who need apply (contrary).

Some cowards are persons who need apply (contradictory).

3. Socrates was the wisest man in Athens (original)

Socrates was not the wisest man in Athens (contrary and contradictory).

4. Not all men are brave (original proposition).

L. F. Some men are not brave.

Some men are brave (sub-contrary)

All men are brave (contradictory).

5. No man but a traitor would have done this (original proposition).

L. F. All those who have done this are traitors.

No persons who have done this are traitors (contrary.)

Some persons who have done this are not traitors (contradictory.)

II. Suppose a man said All children are greedy and you disagreed with him, would you reply with an E or O proposition? Which would give you the best chance of proving yourself right?

Ans.—

The given proposition is an A proposition. According to the rules of opposition if A is false, E is doubtful, I is doubtful and O is true. Hence we have to reply in an O proposition and not in an E proposition, because E is doubtful.

III. What is the simplest proposition which must be established in order to disprove the following statements: (a) All men desire wealth (b) No man is perfectly happy. (c) Some knowledge is not of any value. (d) Pain alone is evil. (e) All is not lost.

Ans.—

a. This is an A proposition. We have only to establish the truth of its contradictory, that is, O to disprove it. Its contradictory is: 'some men do not desire wealth'.

b. This is an E proposition. This can be disproved by establishing the truth of its contradictory i.e., 'Some men are perfectly happy."

c. This is an O proposition. Its contradictory is: knowledge is valuable.

d. All evil things are painful.

Its contradictory is 'Some evil things are not painful'.

e. All is not lost.

L. F. Some things are not lost. Its contradictory is All things are lost.

EXERCISE V.

I. Distinguish (a) contradictory and contrary terms, (b) contradictory and contrary propositions.

II. Why is it desirable in a controversy to refute statement by its contradictory and not by its contrary? a

III. What can you infer (a) from the truth (b) from the falsehood of the proposition 'we cannot all do all things'.

IV. Take the proposition "All sciences are useful," and determine precisely what it affirms, what it denies, and what it leaves doubtful, concerning the relations of the term "science" and "useful thing."

V. State the the following in strict logical form and give the contradictory and (wherever possible) the contrary of each.

1. There is many a true word spoken in jest.

2. Ignorance is not always a bliss.

3. Few citizens of the country failed to support the prosecution of war.

4. The best of men are but at the best.

5. Life is not all pleasant.

6. Not all the crags are accessible.

CHAPTER VII

IMMEDIATE INFERENCE.

1. Obversion

To obvert a proposition is to change the quality of the proposition without changing its meaning. The rule for obversion is: change the quality of the proposition and substitute for the predicate its logical contradictory.

S′ not-S
P′ not-P

S a P	obversion	S e P′
S e P	"	S a P′
S i P	"	S o P′
S o P	"	S i P′

2. Conversion

In conversion we merely transpose the subject and predicate of a proposition. Two principles must be borne in mind when we convert any proposition; the quality of the convertend must be retained in the converse. No term must be distributed in the converse, unless it is distributed in the convertend.

There are two kinds of conversion viz., simple conversion and conversion by *limitation* or *per accidens.* By simple conversion is meant the direct transposition of the subject and predicate without any other change in the form of the proposition.

E and O can be converted in this way; conversion by limitation is applied to 'A' proposition. In this process A loses its universality, and yields as a result only an 'I' proposition. e.g., 'All crows are

black birds' should be converted into some black birds are crows.'

S a P converse		P i S
S e P	,,	P e S
S i P	,,	P i S

The proposition 'O' does not admit of conversion. Some S is not P, if it is converted becomes some P is not S. But 'S' is distributed in the converse which is not distributed in convertend. One of the rules of conversion states that no term must be distributed in the converse unless it has been distributed in the convertend. We cannot convert 'some two-legged creatures are not men' into 'some men are not two-legged creatures'.

3. Obverted conversion

The rule for the obverted conversion is: first convert and then obvert.

S a P	converting	P i S	obverted converse	P o S′
S e P	,,	P e S	,, ,,	P a S′
S i P	,,	P i S	,, ,,	P o S′

4. Contraposition

Contraposition is a process by which from a given proposition we infer another proposition having the contradictory of the original predicate. The rule for contraposition is: first obvert the original proposition and then convert the proposition thus obtained.

	A	E	I	O
	S a P	S e P	S i P	S o P
By obverting	S e P′	S a P′	S o P′	S i P′
By converting	P′ e S	P′ i S	——	P′ i S

Contraposition is of two kinds *i.e.*, 'partial' and full.' The form 'not-P——S' is the partial contrapositive, and 'not-P——not-S' is the full contrapositive. To get the full contrapositive the rule is to obvert the partial contrapositive.

Partial contrapositive of	A	P′ e S
Full contrapositive	,,	P′ a S′
Partial contrapositive of	E	P′ i S
Full contrapositive	,,	P′ o S′
Partial contrapositive of	O	P′ i S
Full contrapositive	,,	P′ o S′

5. Inversion

The inverse of a proposition is one having 'non-s' for its subject and the same predicate as in the original. Starting with the given proposition, we apply the processes of obversion and conversion alternately till we reach the required result. Like the contraposition, we have partial and full inversion having the forms, 'non-S——P' and 'non-S——non-P' respectively. Only 'A and E' have inversion. For 'A' proposition we must start with obversion first; and for 'E' proposition we must start with conversion first.

		S a P	
By obverting we get		S e P′	
By converting	,,	P′ e S	
By obverting	,,	P′ a S′	
By converting	,,	S′ i P′	(full inverse)
By obverting	,,	S′ o P	(partial inverse)
		S e P	
By converting we get		P e S	
By obverting	,,	P a S′	
By converting	,,	S′ i P	(partial inverse)
By obverting	,,	S′ o P′	(full inverse)

6. Immediate Inference by Added Determinants

In this case immediate inference consists in adding the same 'determinant' or 'qualification' to the subject and predicate of the original proposition. If it is true that S is P, then it follows that A S is A P e.g., a comet is a material body, then a visible comet is a visible material body. Generally this kind of inference is always fallacious since there is the ambiguity of language e.g., 'A singer is a man'; 'A bad singer is a bad man'.

VARIOUS EXERCISES WORKED OUT.

I. Give the immediate inferences of the following propositions:—

1. All are not wise who read much.

L. F. Some who read much are not wise people

S o P

Obversion S i P′

Some who read much are not-wise.

Partial Contrapositive P′ i S

Some people who are not wise are persons who read much.

Full Contrapositive P′ o S′

Some people who are not wise are not persons who do not read much.

Subaltern S e P

No people who read much are wise.

Subcontrary S i P

Some who read much are wise. (doubtful)

Contradictory S a P

All who read much are wise. (false)

Note. In giving the immediate inferences of a proposition, we should not only state obversion, conversion, contraposition etc., but also state the contradictory, subaltern and contrary or subcontrary as the case may be.

2. A noisy man is ever in the right.

L. F. All noisy men are persons who are in the right. S a P

Obversion S e P′

No noisy man is a person who is not in the right.

Conversion P i S

Some persons who are in the right are noisy men.

Obverted Conversion P o S′

Some persons who are in the right are not not-noisy.

Partial Contraposition P′ e S

No person who is not in the right is a noisy man.

Full Contrapositive P′ a S′

All persons who are not in the right are not-noisy.

Partial inverse S′ o P

Some persons who are not noisy are not persons who are in the right.

Subaltern S i P

Some noisy men are persons who are in the right (true.)

Contradictory S o P

Some noisy men are not persons who are in the right. (false)

Contrary S e P

No noisy man is in the right (false.)

Note. The student should work out the contradictory, subaltern and contrary (or sub-contrary) for the following propositions.

3. Sorry her lot who loves too well.

L. F. All those women who love too well are sorry persons.

Obversion S e P′

No woman who loves too well is a person who is not sorry. S a P

Converse P i S

Some persons who are sorrowful are women who love too well.

Obverted Converse P o S′

Some persons who are sorrowful are not women who do not love too well.

Partial contrapositive P′ e S

No person who is not sorrowful is a woman who loves too well.

Full contrapositive P′ a S′

All persons who are not sorrowful are people not loving too well.

Partial inverse S′ o P

Some women who do not love too well are not sorrowful.

Full inverse S′ i P′

Some women who do not love too well are not sorrowful.

4. All lawyers are not formalists.

L. F. Some lawyers are not formalists. S o P

Partial Contrapositive P′ i S

Some not-formalists are lawyers.

Full Contrapositive P′ o S′

Some not-formalists are not not-lawyers.

5. No tale-bearer is to be believed. S e P

L. F. No tale-bearer is a person to be believed.

Obversion S a P′

All tale-bearers are persons not to be believed.

Conversion P e S

No person to be believed is a tale-bearer.

Partial Contrapositive P′ i S

Some persons not to be believed are tale-bearers.

Full Contrapositive P′ o S′

Some persons not to be believed are not other than tale-bearers.

Partial inverse S′ i P

Some people who are not tale-bearers are persons to be believed.

Full inverse S′ o P′

Some people who are other than tale-bearers are not persons who are not to be believed.

Note. The student should work out for himself the immediate inferences where the logical form alone is stated.

6. Few candidates were satisfactory.

L. F. Some candidates are not persons who were satisfactory.

7. Few of us are not in some way infirm.

L. F. Some of us are in some way infirm.

8. Boys will be boys.

L. F. All boys are beings possessing boyish or childish nature.

Obversion S e P′

No boy is a being without boyish or childish nature.

Note. The student should draw for himself the rest of the immediate inferences.

9. All the doctors in the world could not save him.

L. F. No doctor in the world is a person who can save him.

10. Only the impartial reason.

L. F. All those who reason are impartial persons.

Obversion S e P′

No person who reasons is other than an impartial person.

Conversion P i S

Some impartial persons are people who reason.

11. No child ever fails to be troublesome, if ill-taught and spoiled.

L. F. All those spoiled and ill-taught children are troublesome.

12. None but young soldiers run away, and only in their first engagement.

L. F. All those who run away in the first engagement are young soldiers.

13. Not all despots are cruel.

L. F. Some despots are not cruel.

14. More haste less speed.

L. F. All cases of increased haste are cases that tend to diminish speed.

Converse.

Some cases that tend to diminish speed are cases of increased haste.

Contrapositive P′ e S

No case of not tending to diminish speed is a case of increased haste.

15. Britain is an island.

Obversion.

Britain is not other than an island.

16. All but he fled.

L. F. Some people are persons who fled.

17. None think the great unhappy but the great.

L. F. The great people are persons who think themselves unhappy.

18. Him justice leads and truth attends whose means are pure and spotless as his ends.

L. F. All those whose means are pure and spotless as their ends are just and truthful.

19. When Caesar says do this, it is performed.

L. F. All the orders of Caesar are cases which are performed.

20. It is never too late to mend.

L. F. All cases of doing a thing late are cases better than not doing it at all.

II. If 'All who are happy are wise', does it follow that 'All who are foolish are unhappy'?

Ans.

This is an A proposition. Only in contraposition the negative of the predicate of the original proposition becomes the subject. Full contrapositive of A is P'aS' e. g., All not-wise are not-happy hence 'all who are foolish are unhappy' is an inference from the original.

III. 'No psychosis without neurosis; no neurosis without psychosis. Does the truth of the first half of the statement involve that of the second?

Ans.—

This is an E i.e., S e P; its converse is P e S; therefore the conclusion 'No neurosis without psychosis', logically follows from the original.

IV. If the failure of apes to use weapons of defence is indicative of lack of intelligence, may we fairly

conclude that where weapons are used intelligence exists?

Ans.—

The whole argument can be put thus: All the animals that do not use weapons are those having no intelligence; therefore some animals that use weapons are intelligent. The conclusion is the full inverse S' i P' hence the conclusion is logical.

V. Does it follow from "A false balance is an abomination to the Lord, that "A just balance is his delight".

VI. Test the validity of the following inferences:—

(a) A mouse is an animal, therefore a large mouse is a large animal.

Ans.—

This is an inference by added determinants. Very often this kind of inference is fallacious.

(b) A poet is a man, therefore a good poet is a good man.

Ans.—

This is an inference by added determinants. The qualifying epithet 'good' is used ambiguously in two places.

VII. Explain the mutual relations existing between the first and the rest.

1. All geniuses are eccentric.
2. Some people who are not eccentric are not geniuses.
3. All eccentric people are geniuses.
4. None that are not geniuses are eccentric.
5. Some who are not eccentric are geniuses.
6. No one who is not eccentric is a genius.
7. All who are not eccentric are geniuses.
8. Some who are not geniuses are eccentric.
9. Some who are not geniuses are not eccentric.
10. Some who are geniuses are not non-eccentric.
11. Some eccentric people are geniuses.
12. No eccentric people are geniuses.

Ans.—

The first proposition is S a P

Contrary S e P

Subaltern S i P

Contradictory S o P
Converse P i S.
Obverted converse P o S′
Obversion S e P′
Partial contrapositive P′ e s
Full contrapositives P′ a S′
Partial inversion S′ o P
Full inversion S′ i P′

2. P′ o S

This is the subaltern of the contrapositive of the first.

3. P a S

This is the subaltern of the converse of the first.

4. S′ e P

This is the subaltern of the partial inverse of the first.

5. P′ i S

This is the contradictory of the partial contrapositive of the first.

6. P′ e S

This is the partial contrapositive of the first.

7. P′ a S

This is the contrary of the contrapositive of the first

8. S′ i P

This is the sub-contrary of the partial inverse the first.

9. S′ o P

This is the partial inverse of the first.

10. S o P′

This the subaltern of the obverse of the first.

11. P i S

This is the converse of the first.

12. P e S

This is the contradictory of the converse of the first.

VIII. All Jews are clever; what is the logical relation of this proposition to each of the following?

1. Some dull persons are Jews.
2. If a man is clever you may be sure he is a Jew.
3. Some very clever people are not Jews.
4. If a man is not clever you may be sure he is not a Jew.

5. If you meet a clever person you cannot be sure whether he is a Jew or not.

L. F. 1. Some not-clever are Jews.

2. All clever men are Jews.

3. Some clever men are not Jews.

4. No not-clever is a Jew.

5. Some clever persons are Jews.

Original proposition All Jews are clever. S a P

1. 'Some not-clever are Jews' is the contradictory of the partial contrapositive of the original.

2. 'All clever men are Jews' is the subaltern of the converse of the original.

3. 'Some clever men are not Jews' is the sub contrary of the converse of the original.

4. 'No not-clever is a Jew' is the partral contrapositive of the original.

IX. Name the logical processes by which we pass from each of the following propositions to the succeeding one :—

(a) All metals are elements.

(b) No metals are non-elements.

(c) No non-elements are metals.

(d) All non-elements are non-metals.

(e) Some elements are metals.

(f) Some metals are elements.

Ans.—

(a) S a P

S=metals

S′=non-metals

P=elements

P′=non-elements

(a) S a P

All metals are elements.

(b) obverse of (a) S e P′

No metals are non-elements.

(c) Partial contrapositive of (a) P′ e S

No non-elements are metals.

(d) Full contrapositive of (a): P′ a S′

All non-elements are non-metals

(e) Converse P i S

Some elements are metals.

(f) Subaltern of (a) S i P

Some metals are elements.

EXERCISE VI.

I. Reduce the following to the strict logical form and give their immediate inferences :—

1. Four years of study is required for a degree.
2. Only those who have never felt a wound jest at scars.
3. Few men can resist temptation.
4. You cannot be just, if you are not humane.
5. Only the young prefer bravado to experience.
6. Some victories are worse than defeats.
7. Not all who are called are chosen.
8. He envies others' wealth who has none himself.
9. Only ignorant persons hold such opinions.
10. Starvation wages are better than none at all.
11. Not all the riches of the earth can bring happiness.
12. He who is down need fear no foe.
13. Few were saved from the ship-wreck.
14. He was not the only one who was cheated.
15. The most may err as grossly as the few.
16. Only non-nationalists make good internationalists.
17. Not all sectarians are fanatical.
18. Mankind appears to be subject to evolution.
19. Examinations are not fair tests of intelilgence.
20. All bacteria are not harmful.
21. I shall not all die.
22. All our mistakes are not borne by ourselves.
23. All seeds contain albumen.
24. All probable events are possible.
25. All parallel lines are lines which do not meet.

26. What cannot be cured must be endured.

27. Philosophy bakes no bread.

28. All warm-blooded animals are air-breathers.

29. All emotions are compound mental states.

30. What can ennoble sots or fools or cowards?
Alas! Not all the blood of all the Howards.

31. You cannot expect anybody but a schoolboy to remember dates.

32. We smile not only when we are pleased.

33. The price of an article does not always rise immediately after it is taxed.

34. Only the actions of the just
Smell sweet and blossm in the dust.

35. Several creditable witnesses vouched for the fact.

36. With the exception of Mr. Jones, no one escaped.

37. A few men will not suffice to move a steam roller.

38. We cannot all command success.

II. Test the validity of the following arguments :—

(a) If we can be sure that the inconsistent is unreal, we must logically be just as sure that the real is consistent.

(b) Existent circles are all imperfect, there must therefore be something other than existent circles which are perfect.

(c) Only some men are liars, therefore there are some liars who are not men.

III. What is the relation between the first and rest.

1. No intelligent persons are prejudiced.
2. All unprejudiced persons are intelligent.
3. Some unintelligent persons are unprejudiced.
4. Not every prejudiced person is unintelligent.

IV. All crystals are solids.
Some solids are not crystals.
Some non-crystals are solids.
No cystals are not solids.
Some solids are crystals.

Some non-solids are not crystals.

All solids are crystals.

Assign the logical relation, if any, between each of these propositions and the first of them.

V. It is true that 'There is no disgrace in losing when one has done one's best, does it follow that 'Those who win deserve no particular glory'?

VI. If it is true that there is 'No faith without works, does it follow that the doing of works proves that faith is present?

VII. Describe the logical relations of the four following propositions :—

(1) All substances which are material possess gravity.

(2) No substances which possess gravity are immaterial.

(3) Some substances which are immaterial do not possess gravity.

(4) Some substances which do not possess gravity are immaterial.

CHAPTER VIII

SYLLOGISM.

1. The Structure of Syllogism

Aristotle (387—322 B. C.) was the first who systematically worked out the theory of syllogism. Later on a few additions have been made to it; but fundamentally syllogism stands to-day in almost the same form in which he had left it.

Jevons defines syllogism as "the act of thought by which we proceed from two given propositions to a third one, the truth of which necessarily follows from the truth of these given propositions." In a syllogism from two given premises, we get a conclusion. e.g.,

All men are mortal
Plato is a man
∴ Plato is a mortal

The first two propositions are said to be the *premises*, the third is the *conclusion*. It is evident that we do not necessarily derive a conclusion from the combination of *any pair* of propositions whatever, e.g., All men are mortal and all metals are elements. The two statements have nothing in common. In order that two propositions may result in a conclusion, they must have something in common.

The predicate of the conclusion is called the 'major-term' (*sadhya*) and the subject of the conclusion is called the 'minor term, (*paksha*). The premise which contains the major term is called the major premise and the premise which contains the minor term is called the minor premise. Generally the major premise is stated first, the minor second and the con-

clusion last. The common term between the two premises is called 'the middle term' (*hetu*). In the following example, the major term is 'element', the minor term 'Gold' and the middle term 'metal.'

All metals are elements.	Major premise.
Gold is a metal.	Minor premise.
∴ Gold is an element.	Conclusion.

The Indian logician recoginses five members in a syllogism., namely *pratijna* (thesis) *hetu* (reason), *udaharana* (example), *upanaya* (application) and *nigamana* (conclusion).

This hill has fire (*pratijna*).

Wherever there is smoke, there is fire (*hetu*) as in the kitchen (*udaharana*).

This hill has smoke (*upanaya*).

This hill has fire *(nigamana)*.

2. The Rules of Syllogism

I. Relating to the *structure* of syllogism.

(a) A syllogism must contain three and only three terms.

(b) A syllogism must contain three, and only three propositions.

II. Relating to *quantity*.

(c) The middle term must be distributed in one at least of the premises.

(d) No term must be distributed in the conclusion unless it has been distributed in the premises which contains it.

III. Relating to *quantity*.

(e) From two negative premises there can be no conclusion. In other words, one at least of the premises must be affirmative.

(f) If one premise is negative, the conclusion must be negative, and if the conclusion is negative, one premise must be negative.

IV. *Corollaries.*

(g) From two particular premises, there can be no conclusion.

(h) If one premise be particular, the conclusion must be particular.

EXPLANATION OF THE RULES.

The reason for the first and second rules is obvious. It is true that from four terms there can be no inference. If a syllogism contains four terms it commits the fallacy called '*Quarternio Terminorum*' (Fallacy of Four Terms). The following is an example of this fallacy.

All dogs are quadrupeds.
All men are rational
∴ All men are quadrupeds.

But this fallacy may also occur owing to the ambiguity of language, e.g.,

Light is the absence of darkness
Feather is light
∴ Feather is the absence of darkness.

In the above example, the word 'light' is used ambiguously. If the middle term is used ambiguously, the resulting fallacy is called '*the fallacy of ambiguous middle*'. Further in a single syllogism there must be only three propositions; if not it will be a polysyllogism.

The third rule states that the middle term must be distributed once at least in the premises.

All horses are animals
All dogs are animals
∴ All dogs are horses.

In this syllogism, there can be no valid conclusion because the middle term is not distributed once. It commits the fallacy of undistributed middle (*savyabichara*).

The fourth rule states that no term should be distributed in the conclusion which has not been distributed in the premises. If the minor term which is not distributed in the premises is made to distribute in the conclusion, then we commit the fallacy called '*Illicit minor*'. Similarly if the major term is made to distribute in the conclusion when it is undistributed in the premise, then we commit the fallacy called '*Illicit major*'. The following is an example of illicit minor.

All crows are black
All crows are birds
∴ All birds are black.

The following is an example of 'illicit major'.

All cows are animals
No cats are cows
∴ No cats are animals.

The fifth rule states that one premise, at least, must be affirmative. Two negative premises afford no standard, by means of which we can determine anything concerning the relation between the major and minor.

The sixth rule says that if one premise is negative, the conclusion must be negative and *vice versa*. Of the two terms S and P, one is asserted to belong to the middle term, and one is denied to belong to it. This being true, the only conclusion which can be drawn is one in which they are denied to have any relation to each other. Similarly it can be proved that if there is a negative conclusion, there must be a negative premise.

The seventh rule says that from two particular premises there can be no conclusion.

The eighth rule states that if one premise is particular, the conclusion must be particular. The proof of this is that one universal and one particular premise distribute enough terms to give us only a particular by previous rules.

3. The Figures of Syllogism

According to the position of the middle term, syllogism can be divided into four classes or figures as they are called. In the first figure, the middle term occupies the subject place in the major premise and the predicate place in the minor premise. In second figure, the middle term is the predicate of both the major and minor premises. In the third figure, the middle term is the subject in both the premises. In the fourth figure, the middle term occupies the predicate place in the major premise and subject place in the minor.

Fig I.	Fig II.	Fig III.	Fig IV.
M———P	P———M	M———P	P———M
S———M	S———M	M———S	M———S
S———P	S———P	S———P	S———P

4. The Moods of Syllogism

Mood is the form of a syllogism as determined by the quality and quantity of the constituent propositions. By the mood of a syllogism, we mean the combination of propositions A, E, I and O, of which it is constituted. In a syllogism, there are only two premises and each premise must be either A, E, I or O. Hence the greatest possible number of moods will be the number of permutations of these four letters, two taken at a time.

A A	E A	I A	O A
A E	E E	I E	O E
A I	E I	I I	O I
A O	E O	I O	O O

Applying the general rules to the above combinations of premises we get only nine valid moods, *i.e.*, AA, AE, AI, AO, EA, EI, IA, IE and OA.

Note.

In A proposition, the subject alone is distributed and the predicate undistributed and in E both the subject and predicate are distributed. In I both the subject and predicate are undistributed and in O the subject is undistributed and predicate distributed. In other words, in universal propositions (A and E) the subject is distributed and in particular propositions the subject is undistributed. In the affirmative propositions the predicate is undistributed and in the negative propositions predicate is distributed.

5. The Special Canons of the Four Figures

Fig. I M——P
S——M

S——P

(1) The minor premise must be affirmative.

Proof :—Suppose the minor premise is negative, then the conclusion becomes negative, and P is distributed in the conclusion. P must also be distributed in the major premise to avoid the fallacy of illicit major. In other words, the major must be negative. Thus our supposition leads to the absurdity of two negative premises. To avoid this absurdity, the minor must be affirmative.

(2) The major premise must be universal.

Proof :—Since the minor premise is affirmative, the middle term is not distributed in it. In a valid syllogism, the middle term must be distributed at least once; hence the major premise must be universal to avoid the fallacy of undistributed middle.

Fig. II P——M
S——M
————
S——P
————

(1) One premise must be negative.

Proof:—If both the premises are affirmative, the middle term is not distributed even once; and we commit the fallacy of undistributed middle. Hence one of the premises must be a negative to avoid the fallacy. For in negative premise, the predicate 'M' is distributed.

(2) The conclusion must be negative.

Proof :—The proof of this rule is evident. If one of the premises is negative, the conclusion must be negative according to the general rules of syllogism.

(3) The major premise must be universal.

Proof :—Since the conclusion is negative, 'P' is distributed. 'P' must also be distributed in the major premise to avoid the fallacy of illicit major. Universals alone distribute the subject, hence the major premise must be universal.

Fig. III M——P
M——S
————
S——P
————

(1) The minor premise must be affirmative.

Proof:—Suppose the minor premise is negative, the conclusion becomes negative and P is distributed but 'P' must also be distributed in the major premise, i.e., the major premise must be negative. The hypothesis that the minor premise is negative. inevitably leads to the absurdity of two negatives. To avoid this, the minor premise must be affirmative.

(2) The conclusion must be particular.

Proof :—Since the minor premise is affirmative, S is undistributed in it. It must also be undistributed in the conclusion to avoid the fallacy of illicit minor. In other words, the conclusion must be particular.

Fig. IV P——M
M——S

S——P

(1) If either premise is negative, the major must be universal.

Proof :—Suppose the major is negative, the conclusion becomes negative, and P is distributed. But P must also be distributed in the major premise to avoid the fallacy of illicit major. In other words, the major premise must be universal. Similarly it can be proved that if the minor is negative, the major must be universal.

(2) If the major premise be affirmative, the minor must be universal.

Proof :—If the major premise be affirmative, the middle term is undistributed. In a valid syllogism the middle term must be distributed at least once. Hence the minor premise must be universal to avoid the fallacy of undistributed middle.

(3) If the minor premise be affirmative, the conclusion must be particular.

Proof :—If the premise is affirmative S is undistributed. It must also be undistributed in the conclusion according to the rules of syllogism. In other words the conclusion must be particular to avoid the fallacy of illicit minor.

VARIOUS EXERCISES WORKED OUT.

1. Why is I E O is never valid and E I O is always valid in all the four figures?

Proof:—If possible, let there be a conclusion for I E; then it must be negative. Every negative proposition distributes the predicate (Major term). But the major premise I distributes neither the subject nor the predicate. Hence there would be an illicit major; and there can be no conclusion in any one of the figures.

The proof of E I O being always valid is as follows: In the conclusion P is distributed and S undistributed. In the minor premise M and S are both undistributed. Since the major premise is E, both M and P are distributed. Hence it does not commit the fallacies of undistributed middle and illicit major. In short E I O obeys all the rules of syllogism; therefore it is always valid.

2. Prove that the second figure establishes only negative conclusions.

Proof :— P——M
S——M
———
S——P
———

If both the premises are affirmative then it commits the fallacy of undistributed middle. To avoid this fallacy one of the premises must be negative the conclusion must be negative according to the general rules of syllogism.

3. Prove that the third figure establishes only particular conclusions.

Proof :— M——P
M——S
———
S——P
———

If the conclusion is universal, both the premises must be universal and S is distributed in the conclusion. Since S must also be distributed in the minor, the minor premise must be universal negative. And if the minor is E the conclusion must be negative and P is distributed. To avoid the fallacy of illicit major, P must also be distributed in the major premise, that is the major must be negative. But this is impossible since no conclusion can be possible from two negatives. Hence the conclusion must always be particular.

4. Prove that E A is valid in all the four figures.

Proof:—The conclusion is negative and P is distributed. Since the major premise is E it distributes both M and P and the syllogism does not commit any fallacy. If S is distributed in the minor premise, it gives a universal conclusion and if it is undistributed it gives only a particular conclusion. Hence E A is valid in all the four figures.

5. If the major premise is a particular negative, determine the mood and figure.

Proof:—If the major premise is O the conclusion also is O. P is distributed in the conclusion; therefore the major premise must be: some M and is not P. But M is undistributed and the minor premise cannot be negative since it involves two negatives; Therefore minor premise must distribute M. In other words it must be universal and affirmative, i.e., all M is S. Thus the valid syllogism which satisfies these conditions is O A O in the third figure.

6. Prove that in every figure, if the minor premise is negative the major must be universal.

Proof:—If one of the premises is negative the conclusion becomes negative and P is distributed. If the minor premise is negative the major must be affirmative. Affirmative propositions do not distribute their predicates. Hence the major term must be the subject of the major premise. The major term must be distributed in its premise to avoid the fallacy of illicit major. In other words the major must be universal.

7. Prove that O proposition cannot stand as a premise in the first figure, as a major in the second as a minor in the third, or as a premise in the fourth.

Proof: Fig. I M——P
S——M

S——P

If the major premise is O the conclusion is negative and P is distributed. But P is distributed in the major since it is negative. Since the major is negative the minor must be affirmative and M is not distributed in it. M is not also distributed in the major since it is an O proposition; hence it commits the fallacy of undistributed middle; similarly if the minor premise is O, M is distributed. Since the major must be affirmative P is undisbuted. But in the conclusion P is distributed. Hence it commits the fallacy of illicit major.

Fig. II P——M
S——M

S——P

If the major premise is O in the second figure the conclusion must be negative and P is distributed. But P is not distributed in the major since it is an O proposition. Hence it commits the fallacy of illicit major.

Fig. III M——P
M——S

S——P

If the minor premise is O, the conclusion is negative and P is distributed. Since the major must be affirmative, P is not distributed in it. But P is distributed in the conclusion; hence it commits the fallacy of illicit major.

P——M
M——S

S——P

If the major premise is O in the fourth figure the conclusion is negative and P is distributed. But P is

not distributed in the major since it is an O proposition. P is distributed in the conclusion; hence it commits the fallacy of illicit major.

Similarly if the minor premise is O, M is undistributed and the conclusion is negative. Since the major premise must be affirmative M is undistributed; but in a valid syllogism M must be distributed at least once. Hence it commits the fallacy of undistributed middle.

8. Prove generally that when the major term is predicate in its premise the minor must be affirmative.

Proof:—The major term which is the predicate of the major premise must be either distributed or undistributed. If the major term is undistributed in the major premise, it cannot be distributed in the conclusion. As only affirmative propositions do not distribute their predicate the conclusion must be affirmative. Therefore both the major and minor premises must be affirmative. If the major term is distributed in the premise, the major premise must be negative. If the major premise is negative the other must be affirmative according to the general rules of syllogism. Therefore the minor premise must be affirmative.

9. Prove that if the conclusion is universal, the middle term can be distributed only once.

Proof:—If the conclusion be universal negative, one premise must be E and the other A. Thus the three terms will be distributed in the premises, of which, one must be the major the other minor, because both these terms are distributed in the conclusion. Though the middle term occurs twice it is only distributed once. If the conclusion be universal affirmative both the premises must be A. Thus two terms are distributed in the premises, of which one must be the minor term and the other must necessarily be middle term. Hence the middle term is distributed once if the conclusion is universal.

10. Prove that when the minor term is predicate in its premise the conclusion cannot be an A proposition.

Proof:—The minor term must be either distributed or undistributed. If it is undistributed, the conclusion must be particular. But if it is distributed in the premise, the minor premise must be negative. The con-

clusion must be negative to avoid the fallacy of illicit minor the conclusion must be universal but it cannot b A since the conclusion must also be negative. Hence conclusion cannot be an A Proposition.

11. Prove that if the middle term be distributed in both the premises the conclusion cannot be universal.

Proof:—In the first figure, the middle term cannot be distributed twice. If it should be distributed, the major and minor premises will be universal and negative respectively. Since one of the premises is negative, P is distributed in the conclusion. But P is not distributed in the major since it must be affirmative. Thus it commits the fallacy of illicit major. Hence the conclusion must be particular.

In the second figure, if the middle term is distributed twice we have the fallacy of two negatives. In the fourth figure, if the middle term is distributed twice, the major must be negative and the minor universal. P is distributed in the conclusion since one of the premises is negative. To have P distributed in the major, it must be E. But if it is E, the conclusion will become also E S is not distributed in the minor and hence it commits the fallacy of illicit minor. Hence the conclusion must be particular.

In the third figure also if the middle term is distributed twice, both the premises must be A or must be A and E. If one premise is E, it will commit one of the fallacies of illicit major or minor as the case may be. Hence there can be only particular conclusion if the middle is distributed twice.

12. If the major term be distributed in its premise, but used undistributively in the conclusion, determine the mood and figure.

Ans. In the conclusion P is not distributed; hence it must be affirmative. If the conclusion is affirmative both the premises must be affirmative; and affrmative propositions do not distribute their predicates. The middle term must distributed in the minor *ie.*, it must be A.In the major premise P is distributed, that is, it must be A. Thus the syllogism is A A I in the fourth figure.

13. If the major premise and the conclusion of a valid syllogism agree in quantity but differ in quality, determine the mood and figure.

If one of the premises is negative, the conclusion must be negative and P is distributed. Since the major premise and the conclusion differ in quality, the major must be affirmative because the conclusion is negative. Since P is distributed in the conclusion, it must also be distributed in the major premise and it must not be negative, hence the major premise is A. But the conclusion and the major premise agree in quantity i.e., both are universal. The major premise is A and the conclusion E and naturally the minor must also be E.

A	P——M		P——M	A
E	M——S		S——M	E
E	S——P		S——P	E

Hence the valid syllogism satisfying the above conditions may be either Camenes or Camestres.

14. If in a valid syllogism the middle term is distributed only in one premise and the other premise is negative, determine its figure and mood.

Ans.—

If one premise is negative, the conclusion is also negative and P is distributed. If one premise is negative, the other must be affirmative. Affirmative propositions do not distribute their predicates. Hence the middle term must occupy the subject place to get itself distributed. In other words, it must be an A proposition. Since P is distributed in the conclusion, it must be distributed in the major premise. The major premise is O since the middle term is not distributed in it. Then the minor premise is A and the conclusion naturally must be O. Hence the valid mood is O A O in 3rd figure.

15. A valid syllogism with a universal conclusion has only two terms distributed in the premises. Determine its figure and mood.

Ans.—

If the conclusion is universal, the premises must also be universal. If the conclusion is universal, S is distributed. Of the two terms distributed, one is

S and the other is M. P is not distributed. Since the major premise is a universal M must occupy the subject place. Hence the major premise must be A. Since P is not distributed in the conclusion, the conclusion must be affirmative. If the conclusion is affirmative both the premises must be affirmative. Then the minor premise is also A. Hence the valid mood is A A A in the first figure.

6. The Determination of valid Moods

We have already seen that only nine valid moods i.e., AA, AE, AI, AO, EA, IA, EI, IE, and OA satisfy the general rules of syllogism; we have also seen that IE is invalid in all the figures. By applying the special canons of the first figure to the above moods, we get only AA, EA, AI and EI as satisfying them. Adding the proper conclusion in the each case, we have the following :—

AAA, EAE, AII, EIO.

The following combinations EA, AE, EI and AO fulfil the combinations laid down by the special rules of Fig. II. By adding the proper conclusions, we get the following valid moods : EAE, AEE EIO and AOO.

By the application of the special rules of Fig. III, we get the following valid moods, with their proper conclusions added to each AAI, IAI, AII, EAO, OAO, EIO.

In the fourth figure we get AAI, AEE, IAI, EAO, EIO as valid moods satisfying the conditions of the special rules, with their proper conclusions added to each.

7. The Mnemonic Lines

The logicians in the Middle Ages invented a system of mnemonic verses to easily remember the valid moods of the four figures.

Barbara, Celarent, Darii, Ferioque prioris;
Cesare, Camestres, Festino, Barocq, secundae,
Tertia, Darapti, Disamis, Datisi, Felapton,
Bocardo, Ferison, habet; quarta in superaddit,
Bramantip, Camenes, Dimaris, Fesapo, Fresison.

The vowels in each word indicate the valid mood in each figure. The meaning of the consonants will be explained later.

8. The Strengthened and Weakened Syllogisms

A syllogism is said to be weakened when a particular conclusion is drawn in spite of the premises strictly warranting a universal. When the premises of a syllogism warrant us to draw a universal conclusion and if the corresponding particular is drawn, then it is said to be weakend AAI and EAO in Fig I, EAO and AEO in Fig. II are called subaltern moods or weakened syllogisms, e.g.,

All elements are substances
All metals are elements
∴ All metals are substances
Some metals are substances (weakened conclusion).

A strengthened syllogism is a form which employs two universal premises to prove a particular conclusion when only *one* is needed. These are AAI and EAO of Fig III and AAI and EAO of Fig IV. In the third figure the middle term in AAI and EAO is distributed twice, while in the fourth, the major term in AAI is distributed in its premise, but not in the conclusion. These are called strengthened moods, because in each a premise may be reduced to its subaltern particular without affecting the conclusion:

All whales are mammals
All whales are water-creatures
∴ Some water-creatures are mammals

The argument is perfectly valid from every point of view but the middle term is distributed twice. A syllogism like Darapti which contains more than enough to prove the conclusion, is called a strengthened syllogism. The same syllogism is valid even if we use a particular premise e.g.,

All whales are mammals
Some whales are water-creatures
∴ Some water-creatures are mammals

9. Dictum de omni et nullo

The meaning of this principle can be stated in this way. Whatever is predicated affirmatively or negatively of a whole class can in like manner be predicated of any part of the whole class. In other words, whatever is predicated of a class is predicated of the individuals or species within it, e.g., All men are rational, James is a man ∴ James is rational. Aristotle regarded this as the fundamental principle of syllogism. This principle can be directly applied to Fig I. Hence Aristotle regarded the first figure as the perfect and the rest as imperfect figures.

10. Reduction

Reduction is the process by which we transform the moods of an imperfect figure to the moods of the first figure. There are two kinds of reduction viz., direct and indirect.

EXPLANATION OF THE MNEMONIC LINES.

(a) The initial letter in the moods of the last three figures indicate that the moods so-named can be reduced to the moods in Fig. I which has the

same initial letter e.g, 'B' in Bramantip indicates that it should be reduced to Barbara.

(b) 'S' except when it is the last letter of a name, indicates that the proposition denoted by the preceding vowel is to be *converted simply*.

(c) 'P' except when it is the last letter of a name indicates that the proposition denoted by the preceding vowel is to be converted *per accidens*.

(d) 'M' indicates that the premises of an imperfect syllogism are to be transposed, the major becoming the minor, or *vice versa*.

(e) In a mnemonic word, the final 's' or 'p' indicates that the conclusion of the *new* syllogism is to be *converted simply or per accidens*.

DIRECT REDUCTION.

The mood Cesare can be reduced to Celarent by simply converting the major premise.

No P is M	———	No M is P
All S is M	———	All S is M
∴ No S is P		∴ No S is P

Fesapo can be reduced to Ferio by simply converting the major and converting the minor *per accidens*.

No P is M	———	No M is P
All M is S	———	Some S is M
∴ Some S is not P		∴ Some S is not P

INDIRECT REDUCTION.

Baroco and Bocardo must be reduced indirectly.

Baroco. All P is M
Some S not M

∴ Some S is not P

If this conclusion is false, its contradictory must be true i.e.,

All S is P

Make this the minor of a new syllogism with the original major and draw a conclusion.

All P is M
All S is P

∴ All S is M.

But this conclusion contradicts the original minor. Hence 'All S is M' is false. Its falsity is due to the assumed premise 'All S is P'; and if this is false, Some S is not P, the original conclusion becomes true.

To take a concrete illustration.

All Indians are Asiatics
Some Christians are not Asiatics
∴ Some Christains are not Indians.

Having the contradictory of the conclusion as the minor of a new syllogism we draw a conclusion

All Indian are Asiatics
All Christians are Indians
All Christians are Asiatics.

The new conclusion contradicts the original minor; the falsity of the conclusion follows from the falsity of the premise: 'All Christians are Indians' and if this is false 'some Christians are not Indians' becomes true.

Similarly Bocardo can be reduced indirectly.

Some M is not P
All M is S

∴ Some S is not P.

By taking the contradictory of this conclusion with the original minor, draw a conclusion from them in Barbara.

All S is P
All M is S

∴ All M is P.

The new conclusion is false for it contradicts the original major ; hence the assumed premise 'All S is P' is false i.e., the original conclusion 'some S is not P' is true.

To take a concrete illustration.

Some Indians are not Mohammedans
All Indians are Asiatics
∴ Some Asiatics are not Mohammedans.

By taking the contradictory of this conclusion with the original minor, a conclusion is drawn.

All Asiatics are Mohammedans
All Indians are Asiatics
∴ All Indians are Mohamemdans.

The new conclusion is false, for it contradicts the original major ; hence the assumed premise 'All Asiatics are Mohammedans' is false and the original conclusion. 'Some Asiatics are not Mohamedans' becomes true.

Baroco and Bocardo can also be reduced directly. Then the new mnemonic words Faksoko and Doksamosk should be substituted for Baroco and Bocardo respectively. In the new mnemonics, 'K'

denotes obversion of the preceding proposition, 'KS' indicates the contraposition of the preceding proposition. 'SK' signifies that the simple converse of the preceding proposition is to be obverted.

The mnemonic Faksoko indicates that Baroco may be reduced to Ferio by contrapositing the major premise and obverting the minor thus:

All P is M
Some S is not M

∴ Some S is not P

By contrapositing the major, No not-M is P
By obverting the minor, Some S is not-M

∴ Some S is not P

To take a concrete example:—

All Indians are Asiatics
Some Christians not Asiatics
∴ Some Christians are not Indians

Contrapositing the major,
No non-Indian is an Asiatic
Obverting the minor.
Some Christians are non-Indians
∴ Some Christians are not Asiatics.

Similarly Doksamosk signifies that Bocardo may be reduced to Darii by contrapositing the major premise, and making it the minor, and then obverting the simple converse of the new conclusion.

Some M is not P
All M is S

∴ Some S is not P

Contrapositing the major and transposing, the premises,

All M is S
Some not-P is M
∴ Some not-P is S

∴ By converting, Some S is not-P
∴ By obverting, Some S is not P

Some Indians are not Mohammedans
All Indians are Asiatics
∴ Some Asiatics are not Mohammedans.

Contrapositing the major and transposing the premises,

All Indians are Asiatics
Some not-Mohamemdans are Indians
∴ Some not-Mohammedans are Asiatics.

∴ By converting, Some Asiatics are not-Mohammedans
∴ By obverting, Some Asiatics are not Mohammedans.

VARIOUS EXERCISES WORKED OUT.

I. Test the validity of the following arguments:—

(1) All cruel men are cowards, no collegemen are cruel, therefore no collegman is a coward

Ans.—

All cruel men are cowards
No collegemen are cruel
∴ No collegemen are cowards.

This argument is fallacious because it commits the fallacy of illicit major. The major term "Cowards" is distributed in the conclusion but undistributed in the major premise.

Note. First the given argument must be put in the syllogistic form and then we find out the fallacy if any. The following remarks may be useful in reducing an argument to a complete syllogism. Generally the statements following 'therefore', 'hence' etc. will be the conclusions. After finding the conclusion we must find out the major and minor terms, so that it will be easy for us to arrange the argument in a logical order. The

major term must occur in the major premise and minor term must occur in the minor premise. Generally statements following 'because', 'for' etc., are minor premises.

(2) Gold is not a compound substance; for it is a metal, and none of the metals are compounds.

Ans.—

The conclusion is: gold is not a compound substance and the argument can be put thus.

No metals are compounds
Gold is a metal
∴ Gold is not a compound substance.

This is a valid syllogism.

(3) Some useful metals are becoming rarer. Iron is a useful metal and it is therefore becoming rarer.

Ans.—

Some useful metals are becoming rarer.
Iron is a useful metal
∴ It is becoming rarer.

This commits the fallacy of undistributed middle.

EXERCISE VII.

Test the validity of the following arguments.

1. All human productions are liable to error; all books are human productions; therefore they are liable to error.

2. This man shares his money with the poor; but no thief ever does this, therefore this man is not a thief.

3. All trained logicians can detect fallacies but few electors are trained logicians; so that few electors can detect fallacies.

4. Every one desires happiness; virtue is happiness; therefore every one desires virtue.

5. All patrons of arts and sciences are public benefactors; no poor men are patrons of arts and sciences; therefore no poor man is a public benefactor.

6. No pauper has a vote. A. B. is not a pauper therefore he has a vote.

7. The express train alone does not stop at this station and, as the last train did not stop, it must have been the express train.

8. No persons destitute of imagination are true poets; some persons destitute of imagination are good logicians; therefore some true poets are not good logicians.

9. All tyrants deserve to die; Caesar is not tyrant, therefore he does not deserve to die.

10. Some mathematicians are logicians; no logicians are acquainted with the works of Aristotle; therefore some mathemticians are not acquainted with the works of Aristotle.

11. The receiver of of stolen property should be punished, you have received stolen property and you should therefore be punished.

12. He who is most hungry, eats most; he who eats least, is most hungry; therefore he whe eats least eats most.

CHAPTER IX

ABBREVIATED ARGUMENTS.

1. Enthymeme

An enthymeme is a syllogism with one of the premises or conclusion suppressed; when the major is suppressed, it is called an enthymeme of first order; when the minor is suppressed an enthymeme of second order; and when the conclusion is suppressed an enthymeme of third order. Generally the major or minor is omitted; sometimes the conclusion is left unexpressed for rhetorical effect. It is a common observation that we do not argue generally in a complete syllogistic form e.g., 'Iron has weight because it is a material body' is an enthymeme of first order, since the major premise is omitted. The whole argument can be put in a complete syllogism.

All material bodies have weight
Iron is a material body
∴ Iron has weight.

The following is an example of an enthymeme of second order. The Thirty Years' War was long and bitter; for all religious wars are so. Here the minor premise is suppressed.

Expressed syllogistically.

All religious wars are long and bitter
The Thirty Years' War was a religious war
∴ The Thirty Years' War was long and bitter.

Enthymemes of third order are generally used in rhetoric. We can quote the following as an example.

'You all did see that on the Lupercal
I thrice presented him a kingly crown,
Which he did thrice refuse: was this ambition?
(Shakespeare: *Julius Caesar*).

2. The Chains of Reasoning

If a series of syllogisms connected together in such a manner that the conclusion of one stands as a premise of another, the conclusion of this again as a premise of the third and so on, then it is called a polysyllogism. In short, a polysyllogism is a series of syllogisms in which the conclusion of one is a premise of the next. In such a series the syllogism whose conclusion becomes a premise in the next syllogism is called a '*prosyllogism*'; a syllogism one of whose premises is the conclusion of a preceding syllogism is called an '*episyllogism*'.

	D is B	Prosyllogism.
	C is D	
∴	C is B	
but	A is C	Episyllogism.
∴	A is B	

The prosyllogism and episyllogism are relative to one another.

If one or more of the syllogisms composing a polysyllogism are enthymatic, then the syllogism is called an 'Epicheirema'. An epicheirema is not a special form of syllogism but is an abbreviated mode of stating an argument. It is a polysyllogism having certain premises omitted. Epicheiremas are divided into two kinds (1) Single and (2) Double. If only the prosyllogism is enthymatic, it is a single epicheirema.

C is B because it is D
A is C
∴ A is B

Concrete Illustration :—

All kings are fallible because they are men
George is a king
∴ George is fallible.

The argument can be put in a complete polysyllogism.

All men are fallible
All kings one men
∴ All king are fallible.

George is a king
∴ George is fallible.

In a double epicheirema the conclusion is reached from two enthymemes, e.g.,

All S is P because it is R
All M is S, because all Q is S
∴ All M is P

Concrete example :—

All quadrupeds are multicellular
because they are vertebrates
All horses are quadrupeds because all
mammals are quadrupeds
∴ All horses are multicellular.

This can be expressed in a complete polysyllogism.

(1) All vertebrates are multicellular
All quadrupeds are vertebrates
∴ All quadrupeds are multicellular.

(2) All mammals are quadrupeds
All horses are mammals
∴ All horses are quadrupeds.

All quadrupeds are multicellular
All horses are quadrupeds
∴ All horses are multicellular.

3. Sorites

A sorites is a polysyllogism in which only the final conclusion is stated, and which is so arranged that any two successive premises contain a common term. In other words, a sorites is a connected series of syllogisms with all the conclusions dropped except the last, e.g.,

All A is B
All B is C
All C is D
All D is E
∴ All A is E

There are two kinds of sorites (1) the *Aristotelian sorites* (2) the *Goclenian sorites*. In the Aristotelian sorites, the subject of the conclusion is the subject of the first premise, and the predicate of the conclusion is the predicate of the last premise. In the Goclenian sorites the reverse is the case: the subject of the conclusion is the subject of the last premise, and the predicate of the conclusion being the predicate of the first premise.

The example of the Aristotelian sorites is the following :—

All A is B	All horses are quadrupeds
All B is C	All quadrupeds are mammals
All C is D	All mammals are vertebrates
All D is E	All vertebrates are multicellular
∴ All A is E	∴ All horses are multicellular

The special canons of the Aristotelian sorites are :—

(1) Only one premise namely the last can be negative.

Proof :—If we violate this rule there will be two negative premises and from two negative premises nothing can be inferred.

(2) Only one premise, namely, the first can be particular.

Proof:—If we violate this rule, we commit the fallacy of undistributed middle.

The example of the Goclenian sorites is the following :—

All D is E	All vertebrates are multicellular
All C is D	All mammals are vertebrates
All B is C	All quadrupeds are mammals
All A is B	All horses are quadrupeds
∴ All A is E	∴ All horses are multicelluıar.

The special canons of the Goclenian sorites are :—

(1) Only one premise can be negative and that must be the first.

Proof:—If we violate this rule, it leads to the absurdity of two negatives.

(2) Only one premise can be particular and that must be the last.

Proof:—If we violate this rule, we commit the fallacy of undistributed middle.

CHAPTER X.

THE HYPOTHETICAL AND DISJUNCTIVE SYLLOGISMS.

1. Hypothetical Syllogism

The hypothetical syllogism has a hypothetical proposition as the major premise, and a categorical proposition as the minor. The hypothetical proposition consists of two things: antecedent and consequent. The part of a hypothetical proposition which expresses the supposition or condition is known as the *antecedent*, the clause stating the result is called the *consequent*, e.g., in the proposition, If he is kind, he will help you, 'If he is kind' is the antecedent, 'he will help you' is the consequent.

There are two kinds of hypothetical syllogisms (1) *modus ponens* and (2) *modus tollens*. In *modus ponens*, the minor premise affirms the antecedent, and that as a result, the conclusion affirms the consequent.

If A is B, C is D
A is B
∴ C is D

If A is B, C is not D
A is B
∴ C is not D

If A is not B, C is D
A is not B
∴ C is D

If A is not B, C is not D
A is not B
∴ C is not D

In *modus tollens* the conclusion is obtained by denying the consequent.

If A is B, C is D
C is not D
∴ A is not B

If A is B, C is not D
C is D
∴ A is not B

If A is not B, C is D
C is not D
∴ A is B

If A is not B, C is not D
C is D
∴ A is B

The rule of the hypothetical syllogism may therefore be stated as follows:—

Either *affirm the antecedent* or *deny the consequent.* If we violate these rules, we commit the fallacies of denying the antecedent and affirming the consequent.

Though the hypothetical syllogism is different from the categorical in form, yet thereasoning is the same in both the processes.

If there is smoke, there is fire
There is smoke
∴ There is fire

This is a case of affirming the antecedent. This can be expressed in a categorical form thus.

All cases of having smoke are cases of having fire
This is a case of having smoke
∴ This is a case of having fire

Similarly the case of denying the consequent can be expressed in Camestres.

The fallacies of hypothetical syllogism can be expressed in categorical form.

If this bird is a crow, this is black
This bird is not a crow
∴ This bird is not black.

This is the fallacy of denying the antecedent. Categorically expressed the fallacy corresponds to that of *illicit major.*

All crows are black
This is not a crow
∴ This is not black.

To take the case of affirming the consequent.

If this tree is an oak, it will have rough bark and acorns
This tree has rough bark and acorns
∴ This is an oak.

The fallacy of affirming the consequent corresponds to the categorical fallacy of *undistributed middle*, e.g.,

All oak trees have rough bark and acorns
This tree has rough bark and acorns
∴ This is an oak tree.

2. Disjunctive Syllogism

A disjunctive syllogism has a disjunctive proposition as the major and a categorical proposition as the minor. There are two forms of disjunctive syllogism. The first is called the *modus tollendo ponens* or the mood which affirms by denying. The minor premise is negative and the conclusion affirmative.

A is either B or C
A is not C
∴ A is B.

The other form is called '*modus ponendo tollens*' or the form which by affirming one member of the disjunctive series, denies the other.

A is B or C or D
A is B
∴ A is neither C nor D.

3. Dilemma

A dilemma is a syllogism with one premise disjunctive and the other hypothetical. The major premise is always hypothetical and the disjunctive is usually stated in the premise. In practical life, we

are said to be in a dilemma when we have only two courses open to us, both leading to unpleasant consequences.

There are four forms of dilemma.

(1) *Simple constructive.*

If A is B, C is D; if E is F, C is D
But either A is B or E is F
∴ C is D.

Concrete example:—

If a man acts in accordance with his own judgment, he will be criticised;
and if he is guided by the opinions and rules of others, he will also be criticised.
But he must either act in accordance with his own judgment or must be guided by the opinions of others.
∴ In any case he will be criticised.

(2) *Simple destructive.*

If A is B, C is D and E is F
Either C is not D or E is not F
∴ A is not B.

Concrete example :—

If he goes to town he must pay for his railway ticket and his hotel bill ;
But either he is unable to pay his hotel bill or to pay his railway ticket.
∴ He cannot go to town.

(3) *Complex constructive.*

If A is B, C is D; and if E is F, G is H.
Either A is B or E is F.
∴ Either C is D or G is H.

Concrete example :—

If he stays in the room he will be burnt to death,
and if he jumps out of the window he will break his neck;
But he must either stay in the room or jump out of the window,
∴ He must either be burnt to death or break his neck.

(4) *Complex destructive.*

If A is B, C is D; and if E is F, G is H
Either C is not D or G is not H;
∴ Either A is not B or E is not F.

Concrete example :—

If he is clever, he would see his mistake, and if he is candid, he would acknowledge it.
Either he does not see his mistake or he does not acknowledge it;
∴ Either he is not clever or not candid.

Generally the dilemmas are faulty. They can be attacked in three ways.

(1) We can attack the dilemma by showing that the alternatives are not exhaustive and thus we can bring a third alternative which does not produce bad consequences. This is called as '*escaping between the horns*'.

(2) A second way of meeting a dilemma is *to take it by horns.* We accept one or the other of the alternatives and show that supposedly bad consequences do not follow from the premises.

(3) A third way of attacking a dilemma is to propose a counter-dilemma. This is technically called '*rebutting a dilemma*'

To rebut a dilemma we have to transpose the two consequents in the major premise changing each to its negative. In other words, the consequents of the major premise change their places and their quality is changed.

Original dilemma.

If A is B, C is D; and if E is F, G is H
Either A is B or E is F
∴ Either C is D or G is H.

Counter-dilemma.

If A is B, G is not H; and if E is F, C is not D
Either A is B or E is F
∴ Either G is not H or C is not D.

An Athenian mother once proposed the following dilemma to her son and asked him not to take the legal profession.

If you act justly, men will hate you, if you act unjustly, gods will hate you.
Either you must act justly or unjustly.

The son rebutted the mother's dilemma in the following way.

If I act justly, gods will not hate me; and if I act unjustly, men will not hate me
Either I act justly or unjustly
∴ Either gods will not hate me or men will not hate me.

Various Exercises Worked Out.

I. Test the validity of the following arguments :—

1. Whoever believes this is a heretic ; so that you are no heretic for you do not believe this.

Ans.—

All persons who believe this are heretics.
You are not a person who believes this.
∴ You are not a heretic.

This commits the fallacy of *illicit major*. The term heretic ' is distributed in the conclusion but it is not distributed in the major premise.

2. If he claims that he did not steal the goods, why, I ask did he hide them, as no thief ever fails to do?

Ans.—

All the thieves who steal goods hide them.
This man hides the goods.
∴ This man is a thief who has stolen the goods.

This commits the fallacy of undictributed middle.

3. If only the ignorant despise knowledge, this man cannot be ignorant; for he praises it.

Ans.—

All those who despise knowledge are ignorant persons

This man is not a person who despises knowledge.
∴ This man is not an ignorant person:

This commits the fallacy ofillicit major.

4. Of university professors some are zealous investigators, and some good teachers. A is an excellent teacher, and we may therefore conclude that he is not a zealous investigator.

Ans.—

University professors are either zealous investigators or good teachers.

A is a good teacher
∴ A is not a zealous investigator.

This is a disjunctive syllogism of modus tcllendo ponens. Formally this is valid. If the disjunction is mutually exclusive and completely exhaustive, then the argument will be materially true.

5. A miracle is incredible because it contradicts the laws of nature.

Ans :—

All those things that contradict the laws of nature are incredible.

A miracle is a thing that contradicts the laws of nature.

∴ It is incredible.

48477

This is an enthymeme of second order. The argument is valid.

6. If the Snark be a Boojum, the man will vanish away. The man vanished away, therefore the Snark was a Boojum.

This is a hypothetical syllogism. This commits the fallacy of *affirming the consequent.* But the rule is to affirm the antecedent and deny the consequent.

7. He is certainly guilty, for he behaved as a guilty man would do.

A guilty man behaves in such and such a way.
He behaves in the same way.
∴ He is guilty.

The argument is in the second figure. This commits the fallacy of *undistributed middle.*

8. Seeing is believing; hence I refuse to believe in god.

All cases of seeing are cases of believing.
The existence of god is not a case of seeing.
∴ The existence of god is not a case of believing.

This is an enthymeme of second order; but it commits the fallacy of *illicit major.*

9. No really musical person would applaud that. though some of the audience are applauding it.

No really musical person is a person who applaud that
Some of the audience are persons applanding that.
∴ Some of the audience are not musical persons.

This is an enthymeme of third order.

This is valid.

10 A man may be without a vote though he is not a minor; but from the fact that Mr. A. has a vote I am able to infer that he is not a minor.

Ans :—

Some persons other than minors are not persons having votes.

Mr. A. is a person having a vote.
∴ Mr. A. is other than a minor.

The argument is in the second figure. The conclusion is wrong because the second figure proves only negative conclusions.

11. Socrates must have been happy, for wise men alone are happy.

Ans :—

All those who are happy are wise men.
Socrates is a wise man.
∴ Socrates is a happy man.

The argument is in the second figure. It commits the fallacy of *undistributed middle*.

12. It is possible to be a learned man and a fool:

James I was both.

Ans :—

James I was a fool.
James I was also a learned man.
∴ Some learned men are fools.

In other words, it is possible to be a learned man and a fool. The argument is A A I in the third figure. This is valid.

13. What is the use of all this teaching? Every day one hears of a fraud or a forgery committed by some one who might have led an innocent life, if he had never learned to read and write.

Ans :—

All those who commit fraud or forgery have learnt to read and write.

A particular man has learnt to read and write.
∴ That man will commit fraud or forgery.

This is an argument in the second figure. This commits the fallacy of *undistributed middle*. Hence the conclusion is wrong. The uselessness of education does not logically follow from the premises.

14. He must be a Scotchman, for no Scotchman can see the force of a joke.

Ans :—

No Scotchman is a person who can see the force of a joke.

He is not a person who can see the force of a joke.
∴ He must be a Scotchman.

This is invalid for from two negatives nothing can be inferred.

15. How can you maintain that anger is always an evil, and also admit that moral indignation is anger and yet may sometimes be good ?

Ans :—

Some cases of moral indignation are cases of producing good.

All cases of moral indignation are cases of anger.
∴ Some cases of anger are cases of producing good.

This is an argument in the third figure. The third figure proves only particular conclusions. The only logical conclusion is anger is sometimes an evil.

16. I will have no more doctors ; I see that all of those who have died this winter have had doctors.

Ans :—

All those who died in the winter are persons who had doctors.

I will also have a doctor.
∴ I will also die.

But this conclusion is wrong since the syllogism commits the fallacy of *undistributed middle.*

17. No man should be punished if he is innocent ; this man should not be punished ; therefore he is innocent.

Ans :—

If a man is innocent, he should not be punished.

This man should not be punished.
∴ This man is innocent.

This is a hypothetical argument. This commits the fallacy of affirming the antecedent.

18. Only if you break the law you are imprisoned ?

That is why you are let free.

Ans :—

If you break the law, you are imprisoned.
You have not broken the law.
∴ You are not imprisoned (i.e., you are free.)

This is a hypothetical syllogism. This commits the fallacy of *denying the antecedent*.

19. If the train is late, I shall miss my appointment; if it is not late, I shall miss the train: but either it will be late or not late; therefore, in any case, I shall miss my appointment.

Ans :—

This is a dilemma. It can be rebutted thus:
If the train is late, I shall not miss the train; if it is not late, I shall not miss my appointment.
Either the train will be late or not late.
∴ I shall not miss my appointment.

20. All thieves are dishonest; all dishonest persons are immoral; some immoral persons are not punished; therefore, some thieves are not punished.

Ans :—

All thieves are dishonest.
All dishonest persons are immoral.
Some immoral persons are not punished.
∴ Some thieves are not punished.

This is an Aristotelian sorites. This is invalid because it violates one of the rules of sorites. In a valid sorites the first premise can be particular but in this argument the last is particular, hence fallacious.

21. If students are idle examinations are unavailing; and if they are industrious, examinations are superfluous; accordingly, as all students are either idle or industrious, examinations are useless.

Ans :—

This is a dilemma. Generally dilemmas are faulty; hence it can be rebutted.

If students are idle, the examinations are not superfluous; if they are industrious, examinations are not unavailing.

Either the students must be idle or industrious.
∴ Examinations are not useless.

22. None but the contented are happy; none but the virtuous are contented; none but the wise are virtuous; therefore none but the wise are happy.

Ans :—

All those who are happy are contented.
All those who are contented are virtuous.
All those who are virtuous are wise.
∴ All those who are happy are wise.

This is an Aristotelian sorites. This is valid.

23. If all philosophical theories were sound, some would be accepted by a majority of thinkers; but as none are accepted by a majority of thinkers, none are sound.

Ans :—

This is a hypothetical syllogism. This is valid. In a correct hypothetical syllogism we have either to affirm the antecedent or deny the consequent.

24. Motor cycling is an unsatisfactory way of seeing the country. If the roads are good, you travel too fast too enjoy the scenery; if they are bad, you are to uncomfortable to look at it.

This is a dilemma and this can be rebutted.

If the roads are good, you are comfortable to look at the scenery;

If the roads are bad, you do not travel too fast as not to enjoy the scenery.

Either the roads must be good or bad.
∴ Motor cycling is a satisfactory way of seeing the country.

25. Barristers cannot afford to be sincere and no one who is insincere is trustworthy. Therefore no trustworthy people will be found to be barristers.

No barrister is sincere.
Some who are sincere are trustworthy.
∴ No trustworthy people are barristers.

This is an argument in the fourth figure. This commits the fallacy of *illicit minor*.

II. What conclusion, if any, can be drawn from each pair of the following sentences taking two and two to-gether.

(a) Only gentlemen are members of the club.
(b) Some members of the club are not officers.
(c) All members of the club are invited to compete.
(d) All officers are invited to compete.

Ans:—

(a) All members of the club are gentlemen.
(c) All members of the club are invited to compete
∴ Some people who are invited to compete are gentlemen.

This pair alone yields a logical conclusion.

(b) Some members of the club are not officers.
(d) All officers are invited to compete.
∴ Some people who compete are not members of the club.

This conclusion is not correct since it commits the fallacy of *illicit major*. Hence from this pair no valid conclusion can be drawn.

EXERCISE VIII.

I. Identify the following arguments and test their validity:—

1. He need not fear madness, for he has no learning, and learning makes men mad.

2. You say this man ought not to be punished. Am I to infer that you believe him to be innocent? For certainly an innocent man ought not to be punished.

3. Only if an officer is cool-headed he deserves the chief command, and as this officer has not been thought worthy of the appointment, we may conclude that he is not cool-headed,

4. It cannot be contended that honesty is the best policy, and at the same time that a man ought to pursue his own interets, for very often it is against one's interests to be honest.

5. Idiots cannot be men, for man is a rational being.

6. He is a very bad marksman; hence it is safest to stand in front of the object he is aiming at.

7. It is useless to give advice; for if a man is wise he will not need it, and if he is not wise he will go his own way.

8. If wages rise, prices rice. If prices rise, wages rise to overtake prices; there is therefore no prospect of any cessation in the advance of the cost of living.

9. He blushes; therefore he is guilty.

10. It is not true that wealth is the only thing that offers satisfaction, for a good conscience is not wealth.

11. If man were not capable of progress, he would not differ from the brutes; but man does differ from the brutes; therefore he is capable of progress.

12. One must take pains if one is to be a successful man; industry is necessary to taking pains; health is necessary to industry; a regulated diet and sufficient recreation and rest are necessary to health; and, therefore, a regulated diet and sufficient recreation and rest are necessary if one is to become a successful man.

13. If this measure is necessary for the successful prosecution of the war, it can be defended; and only then. But it is not necessary, and therefore it cannot be defended.

14. Fallacies would only be excusable if they were unavoidable; but they are avoidable, therefore they are inexcusable.

15. If trade union leaders really controlled their men, relatively few disputes would issue in strikes. Unfortunalely they do not do so. Hence the recent crop of strikes.

16. He did not take Greek in his degree course; for all candidates must take either Latin or Greek, and he took Latin.

17. Moral exhortations are useless. For good men do not need them and bad men will pay no heed to them.

18. There is no harm in allowing boys to climb trees. If they are confident, they are perfectly safe; if they are nervous, they will not climb high enough to run any risk.

19. To speak of training people to be teachers is unmeaning. For either they have a natural gift for teaching and do not need to acquire it, or they lack the gift and no training can impart it.

20. If a man is single, he is unhappy because he has no one to take care of him; and if he is married, he is unhappy because he has to take care of a wife. As he must be either married or single, there is no escape from misery.

21. He would not face a bullet on the field of battle and he is therefore a coward.

22. If the pain is long continued it is not severe; and if it is severe, it does not last long.

23. If Columbus had never lived, America would still have been discovered; if Newton had never lived, someone else would have discovered the law of gravitation; if Wilberforce had never lived, the slave-trade could not have listed for ever.

24. Athletic games are duties; for whatever is necessary to health is a duty, and exercise is necessary to health, and games are duties exercise.

25. To distrust a person is to treat him as a person who cannot be trusted. To treat him in this way, is to encourge him to think of himself in this way. Distrust breeds dishonesty. We ought then always to trust people until we discover that they cannot be trusted.

26. Wars injure trade and therefore impoverish the community. This, however, amounts to diminishing the means of happiness. Since therefore all that diminishes happiness is to be condemned, entry upon war is wholly reprehensible.

27. Protective duties should be abolished; for they are injurious if they produce scarcity, and they are useless if they do not.

28. Only native-born citizens are eligible to this office; as you have this qualification you need not hesitate to run for it.

29. Ignorance is no crime; as you did not know what you were doing, you should not be punished.

30. The cost of labour depends upon the efficiency of labour; the rate of profits depends on the cost of labour;

the investment of capital depends on the rate of profits; wages depends on the inverstment of capital; therefore wage depends on the efficiency of labour

31. Ease and pleasure quake to hear of death. But my life desireth to be dissolved. (It follows that) my life is full of cares and miseries.

32, If this man were wise, he would not speak irreverently of the scripture in jest; and he were good he would not do so in earnest, but he does it either in jest or in earnest; therefore, he is either not wise, or not good.

33. If competitive examinations do not tend to select the best men, they should be abolished and if they do so tend they should be applied to every appointment. Therfore they ought to be abolished or they ought to be applied to every appointment.

34. The existence of capital punishment would be justifiable, only if it let to a diminution of crime, but it certainly does not do this.

35. If I live for others, neglecting myself, I shall make myself unhappy. If I live for myself, neglecting others, others will make me unhappy. But either I shall live for others or I shall live for myself; therefore I shall be unhappy.

36. It is a greater fault rigidly to censure than to commit a small oversight.

37. Man must be governed by force or by reason. But not by force, for they rebel against it, nor by reason, for few listen to it; therefore it is impossible to govern them.

38. When all is said, it remains true that there are but three ways of living possible in this world: by robbing or by begging; to beg is infamous; to rob is criminal: if a man will not work neither shall he eat.

39. If logic deals with matter of fact, it must consider the whole of it, and then be identical with all science, or consider only a part of it, without being able to give a reason why it should choose one part rather than another. But both these alternatives are absurd. Therefore logic does not consider the matter of thought.

II. Give concrete examples of the following:—

(a) A hypthetical syllogism in which the consequent is denied.

(b) The modus tollendo ponens.

(c) A complex constructive dilemma.

(d) A Goclenian sorites containing a particular premise.

PART II.

INDUCTION.

CHAPTER XI

THE PROBLEM OF INDUCTION.

We get knowledge by thinking. Thinking is an intellectual process which furnishes knowledge. In deduction, or in syllogism we infer certain conclusions from the given set of premises. Given the premises, the conclusion necessarily follows. In a syllogism we have three parts: major premise, minor premise and conclusion. The truth of the conclusion is based on the premises. In deduction, we are concerned with the relation between a conclusion and its premises. The truth of the major premise is not in question, but is simply assumed; in other words, the premises are taken for granted. Deductive logic is interested primarily in what it can get out of these assumed premises by applying the rules of logic and drawing conclusions which are consistent with them.

Now the question is: How do we get the major premise or universal. It may be said that the major premise is a conclusion of another syllogism and in turn the major premise of that syllogism may be the conclusion of another syllogism and so on *ad infinitum*. But somewhere this process of formal reasoning must have an end. Can this be possible? No. Ultimately we will have a universal which is not the conclusion of any syllogism. Then, how do we arrive at this universal. *Evidently this is the problem of induction.* Inductive reasoning or induction as it is called is the obtaining of the universal from the particular facts. Induction, then, is generalisation or universalisation based on particular instances. From a few instances of falling of bodies we get the proposition or law: All bodies

gravitate. Thus we see induction is based on experience; we appeal to nature for knowledge; we study nature and discover certain uniformities or laws in her behaviour. In short, the problem of induction is: how we are able to derive from experience general propositions or principles (*vyapti*). In induction we go from the particular to the universal and in deduction from the universal to particular. As Creighton says: "The process of generalisation or passing to a general conclusion on the ground of certain instances or cases that have been advanced may be called induction."

CHAPTER XII

THE STAGES IN INDUCTIVE PROCEDURE.

Induction is generalisation based on particular facts. As we have said it is a process from the particular to the universal. It is not a mechanical jump or leap from the particular to the universal. Induction or scientific method is a complex mental process. It is not based on pure enumeration or counting of instances. But it is based on the scientific analysis of content. This involves a number of processes such as observation, hypothesis, verification and generalisation.

First we observe a number of instances. Observation is not a mere passive awareness of things. It is an active mental process; it is guided by interest. Then a hypothesis is framed to explain these observed facts. A hypothesis is merely a supposition; it is a suggestion or tentative guess which can explain certain observed facts. Then comes verification; we deduce consequences from the hypothesis. And these conclusions are compared with the actual facts. If they tally with them, it is accepted, if not, it is rejected. After rejecting the original one, another hypothesis is framed and tested with reference to actual facts. If it can explain them, then, it becomes a generalisation. Forthwith it is called a law or generalisation. In other words, if our hypothesis is verified, then it becomes a generalisation. At times we have to resort to experiments to find out the truth of rival hypotheses. Every experiment involves some supposition as to a possible connection, which it is intended to confirm or disprove. In certain cases we verify a hypothesis by an expriment.

We shall cite a concrete illustration. Newton first observed a number of falling bodies. This is the first stage in his great discovery. To explain these facts, he formulated a hypothesis of universal gravitation which states that every body attracts another body with a force directly proportional to the sum of their masses and inversly proportional to the square root of their distances. In the earth, owing to the little amount of gravity of bodies we do not see any force exerted by the falling bodies. He extended this theory to the solar system and found that all planets obeying the law of gravitation. Thus the law has been verified. The final stage is generalisation when the hypothesis of gravitation becomes a law or fact.

To take another illustration. We generally observe a number of bodies falling to the earth. Heavy bodies like coin, stone, etc., fall to the ground more quickly than the light bodies, like paper, feather etc., This is the stage of observation. Two hypotheses are formulated: the one states that the difference in their times of falling is due to the difference in their weights. The other one states that the difference in the times of their falling is due to the resistance of the air. These two hypotheses must be tested or verified. To verify them we perform an experiment. In a bell-jar the air is pumped out and a coin and a feather are allowed to fall. Now they fall together simultaneously. Hence the first hypothesis is rejected since it does not tally with the actual facts, whereas the other one becomes a general law since it explains the actual facts. The general law states that the difference in the times of falling of bodies is due to the resistance of the air and not due to the weight. Thus we see that induction involves various processes like observation hypothesis, experiment etc.

EXERCISE IX.

1. Explain the relation between syllogistic logic and inductive reasoning.

2. Describe the various stages in the inductive procedure.

3. Explain the method of induction by means of a concrete example.

4. Explain the distinction between the induction by enumeration and induction by analysis.

5. 'Induction is based on the perceptive analysis of content' Explain.

6. Briefly describe the essential steps of the inductive process (1928).

7. "Induction may be defined as the operation of discovering and proving general propositions".

Is this definition satisfactory? What do you take to be the essence of induction? Can it ever yield more than probable conclusions?

CHAPTER XIII

INDUCTIONS IMPROPERLY SO-CALLED.

1. 'Perfect' and 'Imperfect' induction of Jevons

Scientific induction is based on the analysis of content. It is a complex process. But according to Jevons induction is based on enumeration or counting of instances. He says "an induction is called perfect when all possible cases or instances to which the conclusion can refer have been examined and enumerated in the premises". He calls induction based on incomplete enumeration as imperfect induction. In other words perfect induction is based on the complete counting of instances; and imperfect induction is based on the incomplete counting of instances. After examining all the books in the shelf, I say that all books deal with logic. After counting the number of days of all the months of the year, I say all the months have less than thirty-two days. These statements are examples of perfect induction. Perfect induction is reached after completely examining the instances. 'All crows are black', 'all men are mortal' 'all whales are mammals' are imperfect inductions since we have not examined all the crows or men or whales. The so-called perfect induction is nothing but a collective judgment. It is no induction at all since there has been no conclusion arrived at which is really general. As Creighton remarks "This would be nothing more than a summation of results and not a genuine induction at all". In it the conclusion is based only on an exhaustive enumeration. It is an abbreviated statement of the observed instances. This mode of inference is of very little value except as a short-hand device.

W. E. Johnson aptly calls this as 'summary induction'. Further complete enumeration gives us what is and not what must be.

2. Parity of Reasoning

This is a kind of mathematical reasoning. This kind of reasoning is made use of when we prove a geometrical theorem by means of a diagram. Thus having proved that the three angles of a triangle ABC are equal to two right angles, we conclude that this is true of every triangle, not because we find it true of ABC but for the same reasons which proved it true of ABC. Parity of reasoning is nothing but identity or similarity of reasoning. Mill rightly denies that it is in induction, because the conclusion is not believed on the evidence of particular instances. In other words, though the conclusion arrived at is really general, yet we do not believe it on the evidence of a particular case or cases, but because we see that the same evidence which established the particular case, will apply to every other case coming under our conclusion.

3. Colligation of Facts

Mill defines it thus: "Colligation is that mental operation which enables us to bring a number of actually observed phenomena under a general description; or which enables us to sum up a number of details in a single proposition." Colligation of facts is bringing various facts under a general standpoint. For example, Kepler having observed a number of successive positions of Mars in its orbit, brought them all together under the conception of an ellipse. After observing the successive positions of comets for certain years, astronomers thought that they describe parabolas. Whewell calls this as an induction but Mill does not accept this. Colligation

of facts under a given idea or conception is a preliminary step in inductive generalisation, but in no sense it can be called a complete induction.

4. Enumerative Induction

Enumerative induction is based upon enumeration or counting *(bhuyodarsana).* Jevons calls this as imperfect induction. After counting a large number of instances we make a generalisation. Enumerative induction is a generalisation based on counting of instances. It is the process of formulating a generalisation on the basis of an enumeration of several or at least a relatively large number of positive instances. After observing a connection to hold good in a large number of cases, we universalise that connection. After observing a number of instances of crows being black, we say that all crows are black. This is an example of enumerative induction. This is based on repeated observation. The reasoning in this kind of induction is as follows: such and such has been found to be true, no instance to the contrary has ever been met with; therefore such and such is always true. All scarlet flowers hitherto observed have no smell, therefore all scarlet flowers have no smell.

Formally enumerative induction can be expressed thus:—

A, B, C etc., are mortals.

A, B, C etc., are men.

∴ All men are mortal.

This is an argument in the third figure of syllogism. The conclusion is invalid since the third figure proves only particular conclusions. Hence the universal conclusions are only probable.

Enumerative Induction and Scientific Induction Compared.

(a) Enumerative induction is based on counting of instances; it is purely an observational method. But scientific induction is a complex process involving observation, hypothesis, verification and generalisation. The business of induction is not counting of instances but scientific analysis of the content. In other words scientific induction tries to discover a law by analysing the instances and reading it out of them, rather than by merely summing them up. It can be based on a single instance only, e.g., a single experiment of the combination of oxygen and hydrogen will prove that water is composed of oxygen and hydrogen.

(b) Enumerative induction gives only categorical statements whereas scientific induction gives us hypothetical statements. The one gives only bare co-existences and the other necessary connections.

(c) The principle involved in scientific induction is that of elimination. The causation is proved by eliminating the non-essential features. The one is a principle of elimination, the other is one of enumeration.

(d) Formally scientific induction can be expressed in a disjunctive syllogism with the disproof of its alternatives. But emumerative induction can be expressed in the third figure of syllogism.

The Defects of Enumerative Induction.

Enumerative induction is based on counting of instances; therefore it is not strictly scientific. The real business of induction is to analyse a complex phenomenon and to find out a causal connection. A mere factual connection between two things P & Q. though observed a thousand times, does not warrant

the universal all P is Q. Mere number of instances has no logical force. In fact, real induction is more than a mere citation of certain instances. As Bacon says, " Induction which proceeds by merely sighting instances is a childish affair, and being without any certain principle of inference; it may be overthrown by *a* contradictory instance." In other words one negative instance may nullify the whole conclusion. The conclusion reached by it can only be *probable* but cannot be *certain*. As Bosanquet remarks. "The common idea of inference from many cases, because they are many, to all cases of the same kind, is quite without justification." The fundamental defect of enumerative induction is that the conclusion based on it cannot be verified. Further it is based on incomplete observation. Further many great discoveries have been made by a careful study of two or three instances. This fact alone is sufficient to refute the value of enumeration.

Value of Enumerative Induction.

(a) Thoug enumerative induction is defective in many ways, it is not devoid of any value. Enumeration of instances or collecting data is the first step in every exprimental enquiry. It plays an important part in the preliminary stages of scientific investigation. It is the beginning rather than the end of induction. Enumeration not merely groups phenomena to be studied in a compact form, but at rhe same time begins the process of analysis revealing resemblances and differences.

(b) Enumeration suggests a hypothesis. It hits upon a connection, though the connection remains to be proved. So for as you presume a connection, you are on the road of scientific induction.

(c) Enumeration leads to statistics and calculation of chances. These processes depend upon counting of instances. Enumeration has always a ground. It is always guided by selection and purpose.

(d) Finally there are certain sciences like astronomy, geology meteorology etc., which entirely depend upon observational methods. Experiment is not possible; hence enumerative induction plays a great part in these sciences.

EXERCISE X.

I. 'The so-called Perfect Induction is no induction at all' Explain.

II. Write short notes on :—

Colligation of Facts and Parity of Reasoning.

III. What is meant by enumerative induction? What are its limitations?

CHAPTER XIV.

THE POSTULATE OF INDUCTION.

Postulate is an assumption or presupposition. Every science takes for granted the existence of certain things; without such presuppositions or postulates science cannot progress e.g., Physics takes for granted that there is such a thing as matter which we can touch or see. Induction also proceds on certain assumptions or postulates. It presupposes that events in nature are connected with one another as cause and effect. The postulate of induction is expressed generally in three ways:—

(1) Every event has a cause
(2) Nature is a uniformity
(3) Nature is a unity.

The first postulate of induction or science in general is the law of universal causation which states that every event has a cause. Nothing is uncaused. No event happens without a cause. No phenomenon occurs arbitrarily. In the world, everything is causally connected with one another. Not even a single drop of water in an ocean behaves arbitrarily. If the things are not causally connected, we will be at a loss to know anything. Our life will be always in danger. Without this assumption, no induction is possible. Induction assumes, presupposes, and relies upon this principle. As Lossky points out "No account can be given of induction at all if a perception of the necessary relation of things is denied" When a scientist looks for connection in nature, he is trying to discover them, and not to invent them. He presupposes that there

are such connections. Without such a conviction neither the work of science nor that of ordinary life can be carried on. 'There are unforeseen events, unexpected happenings, or occurrences whose causes we do not know, but not uncaused events or undetermined happenings'.

Another way of stating the postulate is that nature is uniform. There is not only a cause for an effect but also that the same effect is produced by the same cause. Mill calls this as the Uniformity of Nature. Nature is uniform in her ways. In short, nature is a uniformity and not a multiformity. One specific event say 'fire' always produces another specific event 'heat'. In other words, causal connections are necessary and universal; otherwise scientific research is useless. Nature does not behave capriciously or irregularly. By uniformity we mean that a thing behaves in the same manner. It does not mean that everything occurs exactly in the same way as it occurred before. The future does not resemble the past. When we say that nature is uniform, we are not blind to, nor ignore variety in nature. What is exactly meant is: that there is always the reign of law everywhere; and though the same conditions do not repeat themselves, yet the universal laws are always operative. 'Watch the movement of a waterfall, how it breaks into a thousand which seem to shift and hang, and pause and hurry,.........yet there is not a particle of water whose path is not absolutely determined by the forces acting on it, in accordance with quite simple mechanical laws.'

The third way of expressing the postulate is that the world is a system. This is called the unity of nature. Nature is not a chaos, but a cosmos. In the world, facts are connected together in a systematic

order; knowledge is a system. Every scientist must start with the presupposition that world is a connected and systematic whole. It is the major premise in all scientific reasoning.

PROOF OF THE INDUCTIVE POSTULATE.

Nature is uniform in her behaviour. Everywhere there is the reign of law; for every event there is a cause. Such is the presupposition of all science. What is its justification? Can we prove its truth? In other words how do we know that every event must have a cause.

MILL'S VIEW.

Mill says that the postulate is an induction from experience. It is itself proved inductively from the many cases in which it has been found to hold without any exception. In other words, it is the result of simple enumeration.

CRITICISM.

If all induction presupposes the unformity of nature, then the uniformity of nature cannot be proved by induction. How do we know that nature is uniform? Mill answers this question that uniformity of nature is itself proved by an induction. But the uniformity of nature cannot be proved by induction because, unless it is true, induction can prove nothing. We cannot prove by induction that every event has a cause unless the principle of Universal Causation is true. Mill's proof of the uniformity of nature commits the fallacy of *petitio principii*. In other words Mill's proof amounts to the statement that postulate of induction is itself based upon induction. It is like arguing in a circle.

MODERN VIEW.

Knowledge always refers to the objects outside the mind. All the characteristics of knowledge are

found in the world of objects. Logic deals with the logico-mathematical structure of the world. Then the inductive postulate is only a feature of the objects in nature.

THE RELATION BETWEEN THE POSTULATE AND THE LAWS OF THOUGHT.

There are four laws of thought namely the Law of Identity, the Law of Contradiction, the Law of Excluded Middle and the Law of Sufficient Reason. The Law of Identity states that a thing is what it is, as A is A. The Law of Contradiction states that a thing cannot be what it is and what it is not, i.e., A cannot be A and not-A. The Law of Excluded Middle means that a thing must be either the one or the other, as A is either B or not-B. The Law of Sufficient Reason states that for everything there is a cause. The Laws of Thought are ultimately reducible to one great law that nature is a systematic whole where various parts are connected together. The postulate of induction also brings out the systematic nature of things. Hence there is an intimate relation between the two. Hence the postulate of induction is only the law of thought stated in a different form.

EXERCISE XI.

1. What is the presupposition of induction? In what different ways has it been formulated? Which of them do you consider most adequate and why?

2. Can the presupposition of induction be proved?

3. Discuss the relation between universal causation and uniformity of sequence.

4. 'The Uniformity of Nature is the major premise in all induction'. Explain.

5. What is the Postulate of Induction? Show its relation, if any, to the fundamental laws of thought. (1928).

6. What is the Uniformity of Nature? Is its existence consistent with (a) catastrophic changes (b) miracle and (c) magic.

CHAPTER XV.

THE THEORY OF CAUSATION

1. The Meaning of 'Cause'

THE POPULAR VIEW OF CAUSE.

Induction is the discovery of causal connection. It assumes that phenomena are connected causally; without this presupposition there can be no induction at all. Things in the world are connected as cause and effect. What then is the meaning of cause? Suppose a stone breaks the window glass, the stone is commonly spoken of as the cause which produces the effect, that is, the breaking of glass. Popularly 'cause' is considered to have some power or energy to produce some other thing. It is usually said that cause produces the effect; but this notion is wrong. What we actually observe in nature, is that one event follows the other.

HUME'S VIEW OF CAUSE.

Hence Hume defines the cause as the 'invariable antecedent of a phenomenon'. Antecedent is that which precedes or goes before an event and consequent is what follows or comes after the antecedent. In the above example the 'falling of the stone' is the antecedent and the 'breaking of the glass' is the consequent. But Hume's definition is wrong. Day and night follow each other invariably; yet day is not the cause of night; really they are caused by the rotation of the earth.

MILL'S VIEW OF CAUSE.

Hence Mill modifies the definition and states that a cause is an invariable and unconditional antecedent of an event. Mere invariability is not

causation. Thus the sunlight may be an antecedent of the burning of a house but it is not the cause. The cause is a necessary or indispensable thing without which the effect would not take place. Cause is a definite circumstance with which the event will occur and without which it will not occur. Generally cause is not a single circumstance but a sum of conditions. Suppose a man slips down from a ladder and gets himself wounded. Mere slipping down is not the cause; the height from which he has fallen, his constitution, the hardness of the ground etc., must be taken into consideration. To take another example: mere pulling of the trigger is not the cause for the firing of the gun. But the cartridge must be in its place, the striker must be straight, the cap must be in order, the powder must be dry and chemically fit, and so on till it becomes pretty clear that the cause is a totality of circumstances which produce the effect. Therefore Mill further modifies the definition of cause 'as the sum-total of the conditions, positive and negative taken together, the whole of contingencies of every description which being realised, the consequent follows'. The negative conditions are the absence of counteracting agencies.

All antecedents are not causes. Suppose a man runs and falls down, this event may be preceded by the flying of a crow, the barking of a dog etc. Can we say that the barking of the dog is the cause for his falling? This is an accidental antecedent. It is not the cause. Mere coincidence is not causal connection. As Minto says 'mere sequence does not prove consequence'. We must always make a difference between the events *causally* connected and the events *casually* connected. In the above example the barking of the dog is a casual antecedent. If we mistake the casual for the causal antecedent we are said to commit the fallacy of

post hoc ergo propter hoc (after this, therefore on account of this.) Every antecedent of an event is not its cause. This fallacy is committed if a chance connection is mistaken for a causal connection. There may be a number of chance events that precede a phenomenon: but these should not be taken for causes In the above example, if we take 'the barking of the dog' as the cause for his falling we commit this fallacy.

SCIENTIFIC VIEW OF CAUSE.

Cause is the necessary and indispensable and unconditional antecedent of a phenomenon. If certain microbes enter the human body, the disease follows after some time. It seems as though there exists some time-interval between the cause and effect. But in fact cause and effect are not *discrete* events but *continuous*. Even in the above example, as soon as the microbes enter the body, the effect begins. Cause is not separated by any time-interval. Causal relation is a continuous process. This makes it impossible to separate the cause and effect, as beads in a string. Further modern science insists on the reversibility of cause and effect: we can go from cause to effect, or from effect to cause. In a word, cause and effect are reciprocal and reversible. Cause, then is necessary or indispensable for the production of the effect: the cause is the circumstance in whose presence the event always takes place and in whose absence it never takes place. Wherever a regular sequence in events indicates a necessary and reciprocal connection the events in question are said to exhibit the causal relation. This is the real meaning of causality in science.

2. The Plurality of Causes

Mill says that an effect may have a plurality of causes. In other words, the same effect may be

produced by a number of causes e.g., heat is caused by various things: friction, electricity, chemical action, etc. Unconsciousness is produced by bhang, chloroform etc. Thus we find an effect having a number of causes. Is it true that single effect has a plurality of causes? The plurality disappears before any exact scientific investigation. Strictly speaking, this view is untenable. Death may be caused by different things: strangling, poisoning, stabbing etc. Superficially speaking, death is the same in all cases. But if we have a strict post-mortem examination of the dead body, we are sure to find a difference between the death due to poisoning and the death due to strangling. Take the case of diseases which are caused by microbes. But if we analyse the cause of each kind of disease, we find each one has its own characteristic microbe. Thus we see from a strict scientific point of view, this view falls to ground.

But from a practical point of view there is much to be said in favour of it. This is a practical working caution. In the absence of scientific knowledge of the immediate cause, we have to bear in mind that different combinations of circumstances may bring about the same event. In the beginning stage of our scientific investigation, we must always start with the assumption of plurality of causes. But scientific ideal is to abandon this notion. The aim of the scientist is always to find out the specific event which produces its characteristic effect. Science always aims to establish the reversibility of cause and effect. In formal reasoning, the fallacy of affirming the consequent is due to the existence of plurality of causes e.g. If a man has taken poison, he dies, but if he dies we cannot say that he has taken poison.

3. The Intermixture of effects

In certain cases, the effects of different causes intermingle or combine together. As Bain says "the effects of different causes unite in a homogeneous totality". In this case, the effect can not be separated and studied individually, e.g., In an experiment, friction, combustion, compression, electrical action are all occurring at once, each of these will produce quantities of heat which will be added to-gether, and it will be difficult or impossible to say how much is due to each of them separately. This is called intermixture of effects.

4. The Counteraction of causes

Counteraction of causes (*pratibandhaka*) is a special kind of intermixture or effects. It may assume a number of forms. Owing to this, the action of a cause may be (a) increased, (b) diminished, (c) diverted, or wholly counteracted by that of another cause. The effect of any cause is thus said to be neutralised. These counteracting agencies are called tendencies; it should always be remembered that there are no exceptions in the laws of nature. In a tug of war, the rope though pulled at both the ends, may at times stand as it is. Its stationary position is due to counteraction, the amount of exertion on both the sides is the same; hence the rope seems to be stationary. If the aeroplane flies in the air, it does not nullify the law of gravitation; but the force of gravitation is counteracted by the propelling force of the aeroplane.

5. The Plurality of effects

Like the plurality of causes we have the plurality of effects. A cause may produce different effects. This is called the plurality of effects. The sun melts the wax, evaporates water and hardens clay. A

lighted match thrown into water makes a hissing noise, thrown into a haystack a conflagration, thrown into a heap of dry gunpowder an explosion. Apparently it seems that there are different effects for the same cause. But strict scientific investigation will not fail to show that the effect produced by a lighted match falling into water is different from the effect produced by the lighted match setting fire to a hay-stack.

6. The Composition of causes

In composition of causes, two or more causes work together and produce a complex effect which is equal to the sum of separate causes. The laws of parallelogram forces and triangular forces are examples. The elliptical orbit of a planet is due to gravity and tangential force. But in the intermixture of effects, the effects intermingle and produce either a homogeneous or heterogeneous effect.

EXERCISE XII.

I. What is meant in science by the 'cause' of an event? Explain the difference between the practical and scientific senses of the term 'cause'.

II. 'Plurality of causes is due to failure in analysis and disappears before scientific investigation' Explain and discuss.

III. Examine the following argument both in respect of its form and its matter: 'How can we define a cause? If we take it to be the sum of all the conditions, it is indistinguishable from the effect; while if the cause be regarded as consisting of fewer conditions than the whole number, the cause might exist without the effect"

VI. Is it necessary that a cause, as science understands the term, should be (a) antecedent to its effect, and (b) immediately antecedent? Discuss the view that one and the same effect may be produced and by a number of alternative causes.

V. Write short notes on :—

Composition of causes, *post hoc ergo proper hoc*, and Plurality of effects.

CHAPTER XVI.

OBSERVATION AND EXPERIMENT.

1. Observation

(a) Induction is the discovery of uniformities or causal connections. But nature presents to us a mass of innumerable events, together and in succession. The great mass of facts presented to our senses must be analysed into various parts. First we must observe the given facts. Observation is not a mere awareness of what is going on around. It is not staring at things; but it is *an active intellectual process.*

(b) Observation is also guided by *interest.* We observe what we want. Millions of events that pass before a man never enter into his experience at all; they have no interest for him and hence he does not notice them. But the meteorologist observes the direction and the force of the wind and notes the height of barometer, the temperature, the moistness of the air, etc., He observes all these things because he is interested in their study. A man in the street would not care to notice them.

(c) Further observation is a *selective* process. We have to select certain things that are relevant to our problem in view. As we have seen in the above case the meteorologist selects certain things such as the height, of the barometer, temperature moistness of the air etc,, from the various things that are found in the world.

(d) Scientific observation involves *analysis and discrimination.* In observatlon the mind is actively selecting the instances which are relevant to the purpose in view on one hand, analysing and

comparing them with a view to bring them under a general description. In short we analyse a complex phenomenon into various parts.

(e) Every observation involves some *guiding idea* or *hypothesis*. As Darwin says "No one can be a good observer unless he is also an active theoriser". When the meteotorogist observes the height of the barometer and the force of the wind, he assumes or at least he has some notion that the height of the barometer and the force of the wind are connected.

(f) Scientific observation is based on accurate and precise measurement. He is aided by a number of instruments such as microscope, teloscope etc. In the manipulation of the various instruments, the observer must have a training in its technique.

2. Fallacies of observation

(a) NON-OBSERVATION.

At times, we may neglect certain instances which are relevant to our question. We often base our conclusions on positive instances alone, without taking any notice of the evidence afforded by the negative instances. As a rule we see only those instances which are favourable to the theory or belief which we have. As Bacon says "Men mark when they hit and never mark when they miss". When we ignore the negative instances in our generalisation, we are said to commit the fallacy of non-observation. Bacon gives a story of an unbeliever who was shown a temple where a nnmber of portraits of persons were hung who had escaped shipwreck after praying to god. The unbeliever subsequently put the question: 'Where are the portraits of those who have perished in spite of their vows'. This story clearly indicates that very often our conclusions are ill-founded since we neglect the negative instances". All superstitions are of a similar nature.

(b) MAL-OBSERVATION.

Mal-observation *(pratyakshabhasa)* is an illusion. Very often people misinterpret the sense impressions presented to them. If we take a rope for a snake in the darkness this is a mal-observation. Mal-observation is based on misinterpretation or mis-judgment. "The rustic who takes a tombstone brightened by the rays of the moon for a ghost or who interprets a donkey's bray as the voice of a departed ancestor falls into the fallacy; of mal-observation".

3. Experiment

In observation one must wait for events to occur and must take them in the form in which they are presented to us; but in experiment we control the conditions and produce the phenomenon to be investigated in any order and as often as we choose. In experiments we need not wait for the occurrence of the phenomenon. As Bacon says "In experiment we can put definite questions to nature and compel her to answer". In experiment we can vary the conditions and observe the changes which they produce. In experiment we can create a phenomenon at any time and as often as we please. In it the scientist introduces or removes conditions to see what will happen. The scientist prepares oxygen in a bell jar and introduces a red hot splinter into the bel-jar and finds that it burns brilliantly. In this experiment the scientist has arranged a new condition and finds the property of oxygen.

4. Difference between Observation and Experiment

In observation the mind simply finds what is presented to it in nature, while in experiment the answer to a question is obtained by actually controlling and rearranging the circumstances at will. In observation we merely find things as they are given; but

in experiment we remove or introduce certain conditions and find the results. In a word we interfere with nature. Air is found every where; in an experiment air can be completely removed by producing a vacuum.

It is generally said that observation is passive and experiment is active but this is wrong; both the processes are active. Experiment is only an observation of a phenomenon under our control. In observation we do not control, modify or vary the conditions, whereas in experiment we modify or vary circumstances. In it we meddle with nature and force her to answer our questions; we produce the event under conditions which we have ourselves prearranged and carefully selected.

The use of scientific instruments such as telescope, microscope cannot render observation experimental unless the circumstances under observation are actually affected and controlled thereby. Astronomers may select suitable time and place for making an observation; but this is not experiment. Looking blood through a microscope is observation. To create a vacuum by an air-pump is an expriment. As Bosanquet says "Experment is not merely observation under artificial and determinable conditions, *but observation under determinate conditions which you constitute an integral part of the image or product to be observed*". Dissection of a body is observation whereas vivisection is experiment, for in a vivisection certain portions of the brain are anaesthetised and the resulting effects are observed.

5. The advantage of expriment over observation

(1) Experiment enables us to *multiply* our instances indefinitely. The astronomer must wait for

the total eclipse of the sun. But in exprement, we can produce a phenomenon any number of times.

(2) The experiment also helps to *isolate* the phenomenon we are studying. In an experiment we can remove air completely in a bell-jar and find whether the sound of an electric bell placed in it is audible. We introduce or remove certain conditions at a time to discover which of them are relevant or irrelevant to the production of an event. The purpose of experiment is to simplify the conditions of observation by eliminating what is unessential.

3. It enables us to *vary* the surrounding circumstances indefinitely and prearrange and select the conditions that are essential to a problem.

4. Experiment is the only means to *prove causition*, We can take the supposed cause and try whether it will produce the effect and thus we can find a causal connection between two phenomena.

5. Experiment *invents* original phenomena which nature left to herself never realises. The scientist evolves new things in his laboratory like liquid hydrogen, pockets dogs, seedles oranges etc.

6. Natural experiment

In astronomy, geology and other sciences, it is difficult to perform experiments since the circumstances are byond our control. But nature sometimes produces a phenomenon of so remarkable a character that she may be said to be making an experiment herself, as in the case of a full eclipse of the sun. It is only in a full eclipse of the sun that corona of the moon was discovered, and Einstein discovered the theory of Relativity only by observing the deflection of the rays of a star near the sun. If nature herself produces a phenomenon then it is called a natural experiment.

7. Crucial experiment

Two contrary hypotheses may account equally well for all known facts. To decide the truth of these two rival hypotheses we resort to a crucial experiment. A crucial experiment is one which is so arranged that the result is bound to support one of the hypotheses only. The difference between an ordinary experiment and a crucial experiment is this: the ordinary experiment is performed to prove or disprove any suggested connection or hypothesis; but the crucial experiment is performed to decide the the truth of two hypotheses both of which can explain many facts. The theory of light affords a well-known illustration of a crucial experiment. Both the wave theory and corpuscular theory accounted fairly well for all the optical phenomena. Foucalt made a crucial experiment which decided in favour of wave theory. But it is difficult to arrange a crucial experiment since both the rival hypotheses can explain the given facts. It is difficult to find an experiment which proves one and disproves the other.

EXERCISE XIII.

I. Distinguish between ordinary and scientific observation, and indicate the main sources of error in each case.

II. How would you distinguish between observation and experiment? What are the special advantages of the latter for scientific purpose.

III. Write short notes on :—

Crucial experiment, Natural experiment and Non-observation.

IV. State whether the following are cases of observation or cases of experiment giving your reasons.

1. Looking through a teloscope a full eclipse of the sun in the Greenwhich observatory.

2. A surgical operation.

3. Measuring the three angles of a number of triangles and comparing them.

4. Artificial cross-pollination.

5. Preparation of hydrogen in a laboratory.

CHAPTER XVII.

STATISTICS AND THE CALCULATION OF CHANCES.

1. Statistics

The methods by which probable laws are determined are usually spoken of as statistical methods or simply as statistics. These methods are employed in such phenomena where causal methods are blocked. It is very difficult to find the connection between the height and weight of individuals or the connection between the rate of foreign exchange and the export of goods. We employ statistical methods to find such connections.

These methods involve various steps. At the outset, we collect various facts and tabulate them into various groups or classess. The way in which the data are classified depends on the purpose of the statistician. In census, we classify the people into males, females, children, educated, uneducated etc. Then we count the number of instances coming under a group. This is what is generally spoken of as the gathering of statistics.

Now comes the work of the statistician. He finds averages to compare groups of phenomena. Suppose we want to to compare the marks of two classes of students, we must find the average marks of each class and then compare one with the other, *Average* is obtained by dividing the total of several quantities by the number of quantities. The marks obtained by the students of one class are the following: 23, 20, 30, 25, 26, 90 and 80; and the marks of the students of another class are: 45, 53, 35, 40, 42, 38 and 41. Though the average of the, two classes is

the same, yet it really gives a very wrong idea of the general intelligence. Average is affected by extremes. To avoid this defect the statistician uses the *median value* to compare various groups. The median value is obtained by arranging the scores of the individuals in order and finding the middle value in the series. In the above example, the median values of the two classes are 21 and 41. The two values fairly represent the general standard of intelligence in each class. The *mode* is the number which occurs most frequently in a group examined. In a class of students getting the following marks 25, 20, 26, 27, 30, 35, 20, 20, 80 and 90, 20 is the mode.

The statistician also employs various methods to find the connection between two sets of phenomena. He represents the facts by means of histograms, ogives, frequency curves etc. By arranging the given data in a frequency distribution we can find some connection between two sets of facts. The figures in the table below, give the distribution of ten thousand insane people in the Madras Presidency in 1921.

Age	Frequency
0—20	1789
20—45	5853
45-100	2358

By considering the above distribution, we find a probable connection between manhood and insanity.

THE VALUE AND DEFECTS OF STATISTICS

(1) The statistical methods are very useful in the sciences like psychology, economics, education etc. Statistics contributes directly towards a clear and comprehensive grasp of facts e.g., it gives some idea of fine and rainy days during a year.

(2) Statistics is the only method at our disposal, where causal methods cannot be employed. It very often suggests that a causal connection between two phenomena. The co-efficient of correlation gives the degree of correspondence between two sets of facts. By arranging the given data into frequency distributions, histograms, ogives etc., certain connections between two sets of things can be discovered. Mortality tables are very useful in doing insurance business.

DEFECTS.

But however the value of statistical methods must be taken with caution, though its use may be widespread. We must never over-estimate the value of statistics. There are two sources of fallacy which must be guarded against. In the first place, the statistician must take enough instances into consideration to make his conclusions reliable. Many conclusions which are given as discoveries are based on insufficient data. Secondly statistics is not always fair. It is sometimes gathered to support a preconceived theory; other statements can be gathered to prove the opposite also. As Yule says 'Statistics should be regarded as ancillary and not essential'.

2. The Calculation of Chances

In every day conversation, we are constantly making statements like 'This is probable, "This may happen' etc. Probability means that the happening of an event is not certain. It is usually said that such a thing is due to chance or accident. But strictly speaking, there is no chance in the word. Every where the law of causation is operative; when we speak of something happening by chance or of some occurrence as probable, we are expressing merely a deficiency in our own knowledge. To assert that

anything happens by chance, is simply to confess our ignorance of the causes which are operative.

If a coin, say an anna is thrown we do not know which side of it will come up. But in cases like these we generally give a numerical statement of the chance of occurring of any particular event. Thus we know that since there are only two sides upon which a coin can fall, the chance of throwing heads in any trial is ½. The probability of an event is expressed by means of a fraction in which the numerator gives the number of possibilities favourable to the particular event, and the denominator states the total number of equally like possibilities. If we take a large number of trials, the mathematical probability reaches certainty. Thus Quetelet made 4096 drawings from a box containing 20 black and 20 white balls. Theoretically, this should have yielded 2048 balls of each colour. The actual drawing resulted in 2066 white and 2030 black balls. Thus when we take a large number of instances theoretical probability approaches certainty.

EXERCISE XIV.

1. What is meant by statistics? What are its limitations?

2. What is meant by chance? Is its existance consistent with the postulate of induction?

CHAPTER XVIII.

MILL'S METHODS OF CAUSAL DETERMINATION.

J. S. Mill formulated five methods viz., the Method of Agreement, the Method of Difference, the Joint Method of Agreement and Difference, the Method of Concomitant Variations and the Method of Residues. These methods are employed to determine the causal connection. But some of these methods depend upon observation and some others depend upon experiment. In these methods mainly two principles are involved: One is by comparing together different instances in which the phenomenon occurs; the other is by comparing instances in which the phenomenon does occur with instances in other respects similar in which it does not.

1. The Method of Agreement

CANON.

"If two or more instances of the phenomenon under investigation have only one circumstance in common, the circumstance in which alone all the instances agree is the cause (or effect) of the given phenomenon" (Mill).

Mellone simplifies the canon thus:

"When observation shows that two events accompany one another (either simultaneously or in succession) it is probable that they are causally connected; and the probability increases with the number and variety of instances".

Jevons states the canon still more briefly:

"The sole invariable antecedent of a phenomenon is probably its cause; the sole invariable consequent of a phenomenon is probably its effect".

PRINCIPLE.

The principle underlying this method is that of observing a number of cases where a given phenomenon occurs, in order to find what other factor is invariably present with it.

SYMBOLIC ILLUSTRATION.

a b c d ——————First instance of P
g f c m——————Second instance of P
k l n c ——————Third instance of P

All the instances of P agree having C and C alone as its common antecedent; therefore C is the cause of P. No other antecedent of P can be its cause because P still occurs even in its absence.

CONCRETE ILLUSTRATION.

After taking the uncooked food, whatever else a man may drink or eat, a person gets indigestion. The antecedents can be analysed thus:

Uncooked food, coffee, bread, indigestion.

Uncooked food, tea, oranges, indigestion.

Uncooked food, ovaltine, cakes, indigestion.

The eating of uncooked food is the cause of indigestion because it is the invariable antecedent of indigestion.

EXPLANATION.

Suppose we want to find the cause of cholera, we have to compare a number of instances of attacks of cholera and find the event which has invaribaly preceded it. It is certain that the cause of cholara must be one among its various antecedents.

If in a number of cases only one circumstance say drinking of bad water can be found which always occurred before the attack of cholera, that one must be the cause of cholera.

REQUIREMENTS.

Firstly we must find all the antecedents of a phenomenon and study them. By taking a great number and variety of instances we can render the analysis more thorough. Secondly we must discover only one circumstance that is common in all the instances. When the phenomenon 'a' is found to be present with 'b' invariably, then the two are connected causally.

DEFECTS.

1. The 'plurality of causes' is a serious obstacle to this method. In the following example:

strangling——death

poisoning——death

the circumstances strangling and poisoning are not to be reckoned as the cause of death, since they are not its invariable antecedents. In short, the real causes will be eliminated by this method, because they are not present in all the instances. Thus the plurality of causes vitiates this method. The Method of Agreement proves that C is *a* cause of P and not that it is the *only* cause. Mill is conscious of this defect and calls it as 'the characteristic imperfection of this method'.

2. The 'complexity of phenomena' is a bar to this method. Nature not only fails to show at a glance what events are really connected, but also does not give us events schematically arranged as a, b, c, d. The phenomena presented to us are

always complex: the major part of induction consists in analysing the complex into various simpler units. But this method takes for granted the hardest part of our work to have been done. One of the important conditions of the method is to find only one invariable circumstance. But even this is very difficult to find since events in nature are intertwined and intermingled. And this method flatly ignores all these difficulties.

3. Further there are cases where certain circumstances are found to be invariably present which are really immaterial to the point under investigation. In the following example,

quinine and water cures fever
phenacetin and water cures fever

Since water is the invariable antecedent, we are driven to the absurd conclusion, that water cures fever.

4. Sometimes the result obtained by this method may be frustrated by what is called 'the reciprocity of phenomena' The reciprocity of phenomena is a case where two events co-exist together. So long as we are dealing with events that are successive, there is no difficulty in applying this method. But if events are successive and co-existent, it is hardly possible to find which is the cause and which is the effect. Burning of the candle and the melting of the wax is a case of reciprocity of phenomena.

5. In certain cases, cause and effect may be successive, but are not causally connected. They do not stand in the relation of cause and effect to each, but they are co-effects of a common cause, For example, lightning and thunder though invariably present, are really the co-effects of frictional electricity in clouds.

The Method of Agreement and Enumerative Induction Compared.

The method of agreement and that of enumeration are observational methods. They discover universal connections by observing different cases of phenomena. But two methods are really different: one proceeds by *elimination* and the other by *enumeration*. The method of agreement analyses the content. It does not merely sum up instances. It finds the causal connection by eliminating the irrelevant and unessential conditions. But the method of enumeration generalises by counting instances. The conclusion is based on repeated observation. The method of agreement establishes the conclusion by analysing the phenomenon and finding the invariable antecedent of it. As Fowler says, 'The method of agreement bases its conclusion not on the quantity but on the character of the instances which it selects'. It observes a number of instances because they are all a little different and so correct each other leading to a better understanding of them. If the instances are exactly the same, as in the case of enumeration, our guess would be still a guess, however instances we may have.

2. The Method of Difference

Canon.

"If an instance in which the phenomenon in question occurs, and an instance in which it does not occur, have every other circumstance in common save one, that one occurring only in the former, that circumstance in which alone the two instances differ, is effect or the cause, or a necessary part of the cause of the phenomenon (Mill)".

Mellone states the canon thus:

"When the addition of an agent is followed by the appearance, or its subtraction by disappea-

rance of a certain event, other circumstances remaining the same, the agent is causally connected with the event.

PRINCIPLE.

Nothing is the cause of a phenomenon in the presence of which it fails to occur.

SYMBOLIC ILLUSTRATION.

P H K——a l g (Positive instance

H K—— l g (Negative instance)

∴ P is the cause of A because the elimination P necessarily involves the elimination of A.

CONCRETE ILLUSTRATION.

If an electric bell is placed in a bell-jar and rung the sound will be audible. If we pump out the air in the bell-jar and then ring the bell, we do not hear any sound. Therefore we infer that air transmits the sound; for the removal of air naturally results in the absence of sound.

EXPLANATION.

The method of difference is essentailly a method of experiment, The method of agreement only suggests a cause, but does not prove it; the method of difference verifies the suggestion afforded by the method of agreement. We have two instances namely the Positive Instance (*anvaya vyapti*) and Negative Instance (*vyatireka vyapti*). In the positive instance two events occur and in the negative they do not occur. The negative instance is obtained by experiment. Experiment eliminates the suggested cause which naturally involves the elimination of the effect. In the presence of air the sound is audible and in the absence of air it is not audible. Hence air is the cause of the transmission of sound, because the elimination of the one involves the elimination of the other.

REQUIREMENTS.

1. Instances must be rigid and definite. They must be exactly alike except that in one the phenomenon must be present and in the other absent. If these conditions are satisfied the method is perfectly rigorous in its proof. If we want to prove that brain is the cause of sensation, we must be very careful in removing the brain so as not to injure any organs at its base; for the suspension of mental activity may be due to the destruction of other organs as well. In otherwords, the essential requirement of this method is that only one circumstance shall be varied at a time.

2. Wherever possible this method must be supplemented by observation. To be effective the experimenter must have complete control over all the conditions. In spite of vigilant observation, certain factors may creep in and frustrate the result. And no experiment is absolutely accurate. That is why the experiment should be repeated by different persons under varied conditions. Experiment should be performed as rapidly as possible; otherwise other circumstances may intervene and nullify the result.

DEFECTS.

(a) In practice it is very difficult to satisfy all the above conditions. The complexity of phenomena, as in the case of the method of agreement is an obstacle to this method. Events in nature are intertwined and intermingled; it is very difficult to discriminate one from the other.

(b) The plurality of causes vitiates this method to some extent. The method of difference proves *a* cause, but to prove that this is the *only* cause, we should scrutinise thoroughly all the possible negative instances. For example, heat may be

produced either by compression, or by electricity. The absence of compression involves the absence of heat and according to this method, we have to conclude that compression is the only cause. This method really breaks down where there is plurality of causes.

(c) The Reciprocity of Phenomena is a hindrance to this method. Events are not only successive but also co-existent in certain cases. In such phenomena, this is hardly useful in its application. Aurora Borealis, magnetic storms, and the spots in the sun appear and disappear simultaneously. In this case there is a mode of connection among the three things, the nature of which has not yet been found. The presence of co-effects of a common cause also affects this method.

(d) The fatal objection is that this method is incapable of application where experimental elimination is not possible. In certain cases it is impossible to remove the suspected cause completely. We know that gravitation is the cause of falling bodies; but it is very difficult to remove the force of gravitation completely in an experiment.

THE METHOD OF AGREEMENT AND THE METHOD OF DIFFERENCE COMPARED

The Method of Agreement is a method of *observation* whereas the Method of Difference is one of *experiment*. The former merely *suggests* causal connections; but the latter establishes or *proves* causal connections. The first method only gives *probable* conclusions; and the second gives *certain* conclusions. The Method of Agreement is of no avail where there are two rival hypotheses. But the Method of Difference tests their validity by means of a crucial experiment. In the Method of Difference we can take the supposed cause and

try whether it will produce the expected result; since we cannot do this by observation, experimental method is the only means to prove causation. In a word, observation alone without the aid of experiment can scarcely prove the causal nexus. Above all, the Method of Agreement can only indicate that two phenomena are invariably *conjoined*, but can never show that they are *causally connected*.

3. The Joint Method of Agreement and Difference

CANON.

"The two or more instances in which the phenomenon occurs have only one circumstance in common; while two or more instances in which it does not occur have nothing in common save the absence of circumstance, this circumstance in which alone the two sets of instances differ is the effect, or the cause, or an indispensable part of the cause of the phenomenon". (Mill)

Robinson simplifies the canon thus:—

" When a variety of positive instances have only one circumstance in common, and a variety of negative instances agree only in having this circumstance absent, it may be inferred to be causally connected with the phenomenon".

SYMBOLIC ILLUSTRATION.

We can analyse the instances where the phenomenon P occurs into the following circumstances.

Instance I	....	*a, b, c, d, e.*
Instance II	....	*f, c, a, g, k.*
Instance III	....	*d, m, b, c, e.*
Instance IV	....	*k, n, c, g, a.*

We can analyse the instances where the phenomenon P does not occur into the following:—

Instance I	....	*b, k, n, g, a.*
Instance II	....	*d, o, b, m, f.*
Instance III	....	*k, l, s, g, b.*
Instance IV	....	*n, e, u, a, f.*

In the positive set of instances we find C and P are invariably connected together. Hence C may be the cause of P. In the negative set of instances our conclusion is strengthened by finding that C and P are uniformly absent in a number of instances.

CONCRETE ILLUSTRATION.

Creighton gives the following as an example of the Joint Method of Agreement and Difference.

POSITIVE SET OF INSTANCES.

Town A: Small police force—efficient schools—severe penalties—inactive churches—licensed saloons.

Town B: Small police force—efficient schools—light penalties—active churches—licensed saloons.

Town C: Large police force—inefficient schools—severe penalties—active churches—licensed saloons.

Town D: Large police force—inefficient schools—light penalties—inactive churches—licensed saloons.

NEGATIVE SET OF INSTANCES.

Town E: Large police force—efficient schools—severe penalties—active churches—no licensed saloons.

Town F: Large police force —inefficient schools—light penalties—active churches—no licensed saloons.

Town G: Small police force—efficient schools—light penalties—inactive churches—no licensed saloons.

Town H: Small police force—inefficient schools—severe penalties—active churches—no licensed saloons.

In the positive set of instances we find an invariable connection between high percentage of crimes and licensed saloons (taverns) In the negative instances these two factors are uniformely absent. This confirms the result obtained by the positive

instances. Hence we conclude that licensed saloon is the cause of high percentage of crimes.

EXPLANATION.

The Joint Method requires two sets of instances. We first compare different instances where two phenomena occur. If they are found to agree invariably, we infer according to the Method of Agreement that they are causally connected; then we verify the suggestion by loking a number of negative instances where the two phenomena are uniformly absent. Thus our conclusion becomes certain. In the first case all the instances agree in having the presence of two events; and in the second case these instances agree in the absence of two events. A familiar example may be quoted to illustrate the working of this method. If I take a particular kind of food, I find that I invariably suffer from a particular form of illness, whereas, if I leave it off I cease to suffer, thus I have a double assurance that that food is the cause of my illness.

REQUIREMENTS.

(1) The first requirement of this metnod is that we must have positive and negative set of instances. The selected events must be relevant and must have some bearing upon our problem under investigation.

(2) The events selected must be diverse. In other words we should not only have a mere number of instances but a variety of instances.

THE DIFFERENCE BETWEEN THE METHOD OF DIFFERENCE AND THE JOINT METHOD.

The Method of Difference compares only *two instances* whereas the Joint Method compares *two sets of instances.* The proof of the one is independent of the other; they mutually supplement and corroborate each other. Further the

Method of Difference depends purely on experiment, whereas the Joint Method depends both on observation and experiment.

A CRITICAL ESTIMATE.

The Method of Agreement merely suggests a causal connection. The Method of Difference proves the connection ; but it proves only *a* cause and not *the* cause. But the Joint Method overcomes the defect of plurality of causes. As Welton and Monahan say " The consideration of negative instances makes the liability to error through the existence of plurality of causes practically negligible."

Theoretically speaking one experiment is sufficient to give absolute proof of causal connection, But in practice there are a number of sources of error. Hence we have to do experiment many times under. different conditions. This is what the Joint Method actually does. In modern science no discovery gets currency until it is verified by different scientists in different laboratories.

4. The Method of Concomitant Variation

CANON.

"Whatever a phenomenon varies in any manner whenever another phenomenon varies in some peculiar manner, is either a cause or effect of that phenomenon, or is connected with it through some fact of causation ". (Mill)

Boyce Gibson simplifies the canon :

" Whatever phenomenon varies in any manner whenever another phenomenon varies in some particular manner is causally connected with that phenomenon ".

PRINCIPLE.

The principle is that even if we cannot remove an antecedent altogether, yet we may be able to modify it in some way short of its total removal.

SYMBOLIC ILLUSTRATION.

A——————————B
⅓A——————————⅓B
∴ A and B are causally connected.

EXPLANATION.

If two events vary, then there is some causal connection between them. In other words, if there is any correspondence between the variations of two phenomena, then we infer they are causally connected.

CONCRETE ILLUSTRATION.

The stopping of a pendulum or the stopping of a rotatory wheel is due to gravitation, friction and the resistance of air. A wheel spinning upon a smooth axle in a bell-jar where the air is completely removed runs a very long time in Borda's experiment, with pendulum the swing was prolonged to more than thirty hours, by diminishing friction, and exhausting the air. In the above experiments, we find that there is a variation between friction, resistance etc., and the time of motion This leads us to believe that there is connection between the stopping of the pendulum or wheel and the resistance of the air and friction.

REQUIREMENTS.

At a time only one antecedent must be varied; we must be very careful to take a single event and modify it to find what other changes it brings about. We must observe a number of instances where the variation occurs.

MERITS.

This method can be used where phenomenon cannot be eliminated or removed, though it can be varied. Further this is very useful in science because it renders the amount of causes relatively definite and exact. The physicist does not think that his work has finished when he discovers that sound is produced by vibration. He carries further his analysis until he can find *quantitative* relations between the amplitude and velocity of vibrations and the loudness and pitch of the resulting tone.

DEFECTS.

(1) This method must be applied with some caution. The two phenomena sometimes do not vary in a regular mathematical way. If one phenomenon is at zero, we cannot say that the other is also at the same. In other words, if one is reduced to zero, the other will still have some positive value. Suppose a man takes a sufficient quantity of food, he is healthy. And if he takes a great quantity of food, it does not follow that he will become more healthy. In short, the change in one event does not bring a corresponding change in the other. As Bain says " parallel variation is sometimes interrupted by critical points, as in the expansion of bodies by heat, which suffers a reverse near the point of freezing".

(2) Further the corresponding variations in two or more phenomena do not necessarily mean that they are causally connected. The connection between Aurora Borealis, magnetic storms, and the spots in sun are invariably connected with one another ; the intensity of the one varies with the intensity of the rest. But we cannot say that they are causally connected. What is the cause of them is not yet discovered.

5. The Method of Residues

First case

CANON.

"Subduct from any phenomenon such part as is known by previous inductions to be the effects of certain antecedents, and the residue of the phenomenon is the effect of the remaining antecedent" (Mill).

PRINCIPLE.

That which is the cause of one thing, cannot be the cause of a different thing.

SYMBOLIC ILLUSTRATION.

We have several phenomena A, B, C followed by several others E, F, G, and we know that A is the cause of E, B is the cause of F, therefore we conclude that C must be the cause of G.

CONCRETE ILLUSTRATION.

Creighton gives the following example: A lamp is lit in a room where a student studies for two hours. He finds the temperature of the room raised from 93 degrees to 95 degrees within the two hours. What is the cause for the additional 5 degrees of heat? There is no heat beyond what is given off from his body as well as from the lamp. If the lamp alone is burnt for two hours, it will only produce an increase of 4 degrees in temperature. By subtracting 4 degrees from the total increase of 5 degrees, we get 1 degree which is the heat given off from the body of the student.

Second case

CANON.

"When any part of the complex phenomenon is still unexplained by the causes which have been

assigned, a further cause for this phenomenon must be sought" (Mellone).

SYMBOLIC ILLUSTRATION.

Suppose we have a complex effect A. And we have explained the seven-eighths of it as due to certain known causes, then the cause of the remainder one-eighth must be sought.

EXPLANATION.

If we are dealing with a complex set of phenomena and we already know the cause of some of them, we conclude that the cause of the remainder is to be found among the antecedents whose effects we do not already know.

CONCRETE ILLUSTRATION.

It was found nitrogen prepared in laboratory was of uniform density; but nitrogen in air was about half a percent heavier than that of the laboratory. The scientists afterwards proved that the increased weight of nitrogen in air is due to an inert gas mixed up with it.

A CRITICAL ESTIMATE.

The method can be employed usefully only when sufficient advance is made in any scientific investigation. The attempt to explain the residual phenomena has led to many important discoveries in science. The discovery of Neptune is due to the application of this method. The path of Uranus has been disturbed; a great amount of the disturbance was explained as due to the influence of the sun and other planets. Even then there remained a residual amount of disturbance unexplained. The astronomers explained the excess amount of disturbance by postulating

the existence of the planet Neptune. But this was not verified by observation for a long time. In 1845 the conjecture became true when Adams and Leverrier independently discovered the planet by their telescopes.

6. Mill's Methods as Weapons of Elimination

The principle involved in all these methods is that of elimination. The nature of causality is such that where cause is present, the effect follows; where it is absent, the effect is absent; wherever it varies, the effect varies, and their variations are proportional; and what is the cause of one is not the cause of a different thing. All these methods eliminate the irrelevant and variable antecedents which fail to satisfy the requirements of causality.

In the Method of Agreement, the variable antecedents of a phenomenon are eliminated, for nothing is the cause of a phenomenon in whose absence the event occurs. In the Method of Difference elimination is effected by an experiment. By means of an experiment the suspected cause can be eliminated and then we find what changes happen in its absence. Thus we eliminate the irrelevant antecedent by means of an experiment. The Joint Method is only a double employment of the Method of Agreement and the Method of Difference. In the method of Concomitant Variations, the cause and effect are partially eliminated. Two events are connected causally, if the partial elimination of the one involves the partial elimination of the other. Even in the Method of Residues we eliminate the amount of known effects from a complex one and then seek the cause of the residue. Thus we see all the methods proceed on the principle of elimination.

EXERCISE XV.

1. Explain the problem which the Inductive Methods are intended to solve, and discuss their success in solving it.

2. Explain and illustrate the Method of Agreement. What are its advantages and defects? How does it differ from induction by simple enumeration?

3. What is a negative instance? Bring out by concrete examples its importance in induction.

4. On what grounds is the Method of Difference called the method of experiment? Under what conditions can it be applied?

5. What is the Joint Method of Agreement and Difference? What advantage does it possess over the Methods of Agreement and Difference separately?

6. "The principles on which the inductive methods proceed are just a detailed statement of the nature of scientific causality" Explain and discuss.

7. What is the method of Concomitant Variations and what are its main uses?

8. What conditions must be satisfied before we can legitimately assert a causal connection between two events?

9. "Mill's methods are merely weapons of elimination". Discuss.

10. Explain the principle on which the method of Residues proceeds, and illustrate its importance in the history of science.

CHAPTER XIX.

ANALOGY.

In ordinary language analogy is often used to denote any kind of resemblance between two things. But in logic analogy is an inference from one instance to another which resembles it in certain respects. *Upamana* in Indian logic does not exactly correspond to analogy. Mill defines analogy thus. "Two things resemble each other in one or more respects; a certain proposition is true of the one, therefore it is true of the other". In other words, analogy is a form of reasoning in which, from the resemblances of two or more things in certain respects, their likeness in other respects is inferred. The principle of analogy is *resemblance.* The following is generally adduced as an example of analogy. Mars and the earth resemble one another in a number of ways; they both revolve round the sun; they are both subject to the law of gravitation; they both have only one moon, therefore we infer that Mars also may be inhabited since it may resemble the earth in that respect also. Analogy is a generalisation based on mere likeness or resemblance.

The analogical argument can be expressed in the second figure.

P which has Q has the following attributes

a, b, c, d, e, f.

S has a, b, c, d, e, f.

∴ S may be P having Q.

Formally this syllogism is defective since it commits the fallacy of undistributed middle.

The Conditions of Good Analogy

The inference from analogy may have all degrees of value. Its worth depends on the importance of the points of resemblances on which it is based. As Creighton says: "an argument from analogy may have any degree of value, from zero almost up to the limit of complete logical certainty". In many cases it may be merely rhetorical rather than logical.

The important condition of analogy is that the points of resemblance in question must be fundamental and relevant. Mere number of points is of no value. As Bosanquet says "we must *weigh* the the points of resemblance not simply *count* them". The resemblance must be essential, the difference non-essential. As Welton says "an argument from analogy depends upon the character of the identity, and not upon the apparent amount of similarity". The force of the argument depends not on the *number* of points but on the *importance* of its details. Regarding the habitability of Mars, the points like its revolution round the sun, its having the moon, etc., are not essential and important. The existence of suitable atmospheric and climatic conditions are fundamental. Hence the probability of the existance of living beings depend on the presence of these features. Similarly two boys may resemble one another in height, weight, strength, place of birth, etc., yet we cannot infer that because one of them is very intelligent, the other will also be like him. In this case mere number of points have been considered. Thus in an analogical argument the resemblances must be relevant and not irrelevant.

The Difference between Analogy and Enumeration

Enumerative induction is based on counting of instances. But analogy proceeds by the analysis of

content. It is based on resemblances; in so far as we consider the points of resemblance it is analysis. As Bosanquet says "It has an aspect of discovery as well as proof". We must not treat analogy as though it were a question of enumeration and consider that the strength of the argument depends on the *ratio* of the number of points of resemblances to the number of points of difference. Mill is thoroughly wrong when he says that the value of analogy depends on the relative number of points of resemblance over that of difference. Mere counting of points of resemblance or difference is of no avail.

Value of Analogy

The conclusion from analogy is only *probable.* No analogy can amount to full proof. It may afford a greater or lesser degree of probability, according as the things compared are more or less similar in their nature.

We have seen already that, as a formal process, analogical argument is fallacious. But analogy is a stage in the inductive generalisation. Analogy takes us an important step beyond mere enumeration. *It is our first tentative effort towards explanation* and it rests on resemblances. The probability of the conclusion depends upon the importance of resemblances.

It suggests *hypotheses.* The analogy of a falling apple suggested to Newton a falling moon. The resemblance between lightning and a spark suggested to Franklin that lightning is due to electrical action.

Sound and Unsound Analogy

Sound analogy is based on relevant and important resemblances. The conditions of a good analogy are that resemblances should be essential and the

differences non-essential. If we infer the inhabitability of Mars from its resemblances with the earth in having atmosphere on its surface, then it is a *sound* analogy. Franklin found that many of the effects of lightning are the same as those produced by electricity. Lightning travels in a zig-zag line, and so does an electric spark, animals can be killed by both, and both cause blindness. Hence Franklin inferred that lightning is electricity passing from one cloud to another. This is a *sound* analogy.

An unsound analogy is based on unimportant points of resemblance. Very often this is more rhetorical than logical. If the points of difference are essential and the points of resemblances are non-essential then there is an *Unsound or false analogy.* The whale and shark resemble in many ways. From these resemblances we cannot infer that whale breathes through the gills like shark. The existence of counterfeit coins implies the existence of good money. In the same way we cannot say that existence of fraudulent spiritual phenomena implies genuine ones. That would be a false analogy.

EXERCISE XVI.

1. Is an analogical argument ever conclusive?

2. Explain and illustrate the conditions which a good argument from analogy must fulfil.

3. What do you mean by analogy? What is the principle upon which it proceeds? What are the dangers in analogical reasoning?

4. Distinguish between a Sound and an Unsound analogy.

5. What is the value of analogy as a method of explanation.

CHAPTER XX.

HYPOTHESIS.

A hypothesis is a supposition which we make to explain any phenomenon. It is a guess or a conjecture which brings various facts to some relation. Then it is a supposition as to the existence of some facts or laws which will serve to explain a fact or connection of facts already known to exist. If we are in doubt as to the cause of any phenomena we make a guess or a supposition and proceed to test it. Such a conjecture is called technically a *hypothesis*. Even in our daily life we are constantly making hypotheses. Every supposition we make to account for any event whatever is a hypothesis. When I go home after the college work is over I find my books in my closet to be in a pell-mell state. To explain the given condition I make a guess that somebody would have entered the room and meddled with the books. As a consequent of my hypothesis, I find whether the door is bolted on not. If the door is unbolted, my conjecture becomes a fact.

In science we observe a number of facts. But we are not contented with mere observation. We want to explain the observed facts by means of some hypothesis.

The suggestion of hypothesis

We have already seen that the formation of a hypothesis is the work of the mind. It requires a scientific genius to see a connection between two facts where the ordinary man may fail to notice any connection.

There are a number of ways by which the hypotheses are suggested. It may be suggested by

enumerative induction. The mind tries to generalise the uncontradicted experience into a universal law.

It may also be suggested by the *Method of Agreement.* We find a number of cases that P and Q are invariably present together. Hence a connection between them is suggested.

Hypotheses of immediate causation are also frequently suggested by *analogy.* By analogy we we infer what is true of an object is probably true of another which resemble it. It does not work out a law of connection between two cases. But it suggests that both the cases may be instances of a general law.

Frequently a phenomenon is explained by established laws, and yet there may remain a discrepancy between the facts as they are observed and the facts as they would be if the known laws amounted for the whole phenomenon. This discrepancy leads to many important hypotheses. The astronomers put forward the hypothesis of Neptune to explain certain discrepancies in the motion of Uranus.

Besides suggestions furnished by various processes, the most important factor that is responsible for the formation of hypothesis is *imagination.* Hypothesis is a product of imagination. A good theoriser like a poet is in a certain sense born and not made. As Tyndall says "Out of the facts of chemistry the constructive imagination of Dalton formed the atomic theory".

The requirements of a good hypothesis

1. The hypothesis *must be based on known facts.* As Tyndall says "it is intimately dependent on the suggestions of accurate experiment and

observation and also on whatever knowledge the investigator possesses".

(2) It must not *contradict* any of the known laws of nature. We must not evolve a new hypothesis which contradicts or disproves a well-established theory. But if the new hypothesis is so decisive and far-reaching in consequences, the well-established theory have to be revised, modified or rejected. For example, the Einstein's theory of Relativity is so decisive that the law of Gravitation is to be abandoned.

(3) It must be *conceivable.* It should not be absurd. It is absurd to posit that people can fly in air without any mechanical contrivance. Further what is inconceivable once can be conceivable at the present time e.g., antipodes was an absurd thing to the ancients.

(4) The hypothesis should be capable of *deductive development.* It should furnish a basis for rigorous deduction of inferences or consequences. The hypothesis should be such that we can deduce certain consequences and test them with reference to actual facts. This is the most important condition of the hypothesis i.e., it must be capable of being *proved* or *disproved.* Unless we can deduce consequences from a given hypothesis, it is useless. For example when the scientists postulated the existence of ether, it can be used as a principle of explanation and consequences can be deduced from it because it is like another material body, though it is very elastic and tenuous (thin). If any person makes an assumption of ghost or soul totally unlike anything familiar to us it would be impossible to prove or disprove it. Such a one is called a *barren hypothesis.* A barren hypothesis is positing of any thing from which no deduction can be made.

Verification

We formulate a hypothesis and deduce consequences and see whether they tally with actual facts or not. If they agree with actual facts then the hypothesis is verified.

Proof

Verification is not proof. The continued conformity with facts is its test. It must not only explain a single group of facts but must also explain independent classess of facts. If large and independent classes of facts point towards a particular hypothesis, then it must be regarded as possessing the highest degree of probability in its favour. This is called the *Consilience of Results*. The hypothesis of evolution is true because it explains large independent classes of facts in biology, palaeontology, phylogeny etc.

Mere verification does not prove the truth of the hypothesis. It has no formal validity. As a formal process, it commits the fallacy of affirming the consequent.

If the law of gravitation is true, the planets move in ellipses.

They move in ellipses.

∴ The law of gravitation is true.

This conclusion is wrong. That is why we must show not only a particular hypothesis will explain the facts, but that is the only hypothesis which will explain them. Until this is done it can only have a high degree of probability.

The Working hypothesis, False hypothesis and Barren hypothesis

A hypothesis which is fruitful but insufficiently verified is called a *working hypothesis.* Psycho-

physical theory in psychology and Conservation of Energy in physics are working hypotheses.

A *false* hypothesis is one which does not tally with actual facts. It is a hypothesis that has been disproved by actual facts. In a word, it does not agree with facts. The Ptolemaic theory in astronomy, is a false hypothesis. A *barren* hypothesis is one which is incapable of deductive development. It can neither be proved nor disproved. It is an unveriable assumption. The hypothesis of ghosts is a barren one.

EXERCISE XVII.

I. Explain and illustrate the part played by hypotheses in scientific investigation.

II. What conditions must a hypothesis satisfy (a) in order to be regarded as scientific, (b) in order to be regarded as established?

III. Can an inductive generalisation ever be logically justified?

IV. Write short notes on :—

False Hypothesis, Barren hypothesis, Consilience of Results, and Working Hypothesis.

V. What part does elimination play in the proof of a hypothesis? Explain the nature of the formal fallacy involved in the statement that a hypothesis is established when its results are shown to be true. How is this difficulty overcome?

VI. What part is played respectively by (1) reason (2) imagination in the formation of a hypothesis?

VII. What are the requirements of a good hypothesis? Distinguish between a barren and false hypothesis (1928)

CHAPTER XXI.

EXPLANATION.

In science explanation shows that some fact or group of facts are related in an orderly way to some other fact. Explanation is bringing various facts under a general law.

The word '*law*' is ambiguous. In ethics and legal science law means a certain injunction externally imposed upon people to be obeyed. These laws are violable and changeable. A law in physical science means a uniformity of nature. It describes the uniform behaviour of things.

Generally a distinction is drawn between an *empirical* law and *derivative* law. An empirical law is only an observed uniformity, as, All crows are black. It cannot be resolved into any other simpler laws. It is purely based on observation. Some of the sciences are in the empirical stage, e.g., medicine. The laws in economics and social sciences are of this nature.

A derivative law is a law which can be derived from a more general law. When a law is shown to be an instance of a more general law, then it is called a derivative law. The reduction of empirical laws into derivative laws is a step in the scientific explanation. A derivative law is a result of wider principle. The occurrence of snow on high mountains was at one time an empiricial law. But now it is a derivative law since it can be brought as an instance ofa general which states that the heat of the sun depends on the amount of its absorption by air.

Observation, Description and Explanation

First the scientist *observes* the phenomena and finds a number of uniformities. He describes the uniform behaviour of things. But he is not contented with mere description. He pushes his analysis further and further. The difference between description and explanation is one of degree, being simply a question of the extent of analysis, Explanation has various degrees of completeness and ultimateness. The function of the scientist is to first trace uniformities in a number of facts and then bring all these uniformities under more general laws.

EXERCISE XVIII

1. 'No explanation in terms of causality is final' Discuss the statement and consider the light which it throws on the limits of the Inductive methods.

2. What is meant by scientific explanation? How are (a) observed phenomena and (b) scientific laws, explained?

3. Discuss the value and limitations of explanation by Analqgly (1928).

CHAPTER XXII.

THE RELATION BETWEEN INDUCTION AND DEDUCTION.

Generally it is said that deduction starts from the universal and reaches the particular and induction starts from the particular and reaches the universal. We may start with some general principle which we already know and try to show that some result necessarily follows. Thus from the relative positions and revolutions of heavenly bodies, astronomical reasoning might lead to the conclusion that an eclipse will take place at a particular time. This method of reasoning is called *deduction*. In *induction* on the contrary we observe a number of particular facts and try to discover a general principle. Thus from the observation of falling bodies, we infer that all bodies gravitate.

But these two processes are not clear-cut and separate. In fact one depends on the other; one supplement the other. It is clear that deduction requires a universal; without the universal there can be no conclusion. We know that the universal is obtained by induction. Hence deduction presupposes induction. Similarly induction depends on deduction. Induction is a complex process involving observation, hypothesis, verification and generalisation. First we observe a number of facts; then we formulate a hypothesis to explain their behaviour. We then deduce certain consequences from the hypothesis and find whether they tally with the existing facts or not. If the inferred consequences agree with the facts, then it becomes a generalisation.

In both the cases, it is the universal connection that gives us the inference. The difference between

the two is only the *starting-point*. If we start with a law, and show that a given instance is an example of it, it is *deduction*. But if we start with the particular facts and trace a general law out of them, then it is *induction*. Hence both deduction and induction are not two kinds of inference, but two aspects ofthe same process. They are not independent but interdependent; not mutually exclusive, but mutually inclusive.

EXERCISE XIX.

1. Explain the relation between deduction and induction.

2. 'The difference between deduction and induction is one of *starting-point* and not one of principle' Explain.

Various Exercises Worked Out in Induction.

I. Identify the following arguments and test their validity.

1. Beeswax, gum-arabic, balsam, all take on the brilliant colouring of mother-of-pearl when they receive an impress from its surface. The only circumstance in common is the shape of the mother-of-pearl. The shape therefore is the cause of the colour.

Ans.—

In this argument, there is an application of the Method of Agreement. The antecedents can be analysed thus:

beeswax, impress of the mother-of-pearl, colours.
gum-arabic, impress of the mother-of-pearl, colours.
balsam, impress of the mother-of-pearl, colours.

Hence the shape of the substance is the cause of colouring because the shape alone is the invariable antecedent of colours. Since the method is an observational method, the conclusion is only probable.

2. It is evident that the green colour of plants holds some necessary relation to light, for the leaves of plants growing in the dark, as potatoes sprouting in a cellar, do not develop this colour. Even when leaves have developed the green colour, they lose it if deprived of light, as is shown by the process of blanching celery and by the effect on the colour if a board has lain upon it.

Here there is an employment of the Joint Method of Agreement and Difference. The set of positive instances are wherever there are plants exposed to sun light, they are green. The negative instance is potatoes in dark cellars having no colour. Another negative instance is that leaves are deprived of their green colour if they are covered by a board.

Thus we find that light is the cause of green colour in plants.

3. War is a blessing, not an evil. Show me a nation that has ever become great without bloodletting.

Ans.—

This is an *unsound analogy.*

4. Worms do not possess any sense of hearing. They took not the least notice of the shrill notes of a metal whistle, which was repeatedly sounded near them; nor did they of the deepest and the loudest notes of a bassoon. They were indifferent to shouts provided that the breath did not strike them. When placed over a table closed to the keys of a piano, which was played as loudly as possible, they remained perfectly calm.

Ans.—

Here the Method of Agreement is employed. The various antecedents can be analysed thus:

Noise of the whistle, no reaction
Noise of the bassoon, no reaction
Shouts, no reaction
Noise of the piano, no reaction.

Thus we see the presence of sound has no effect on worms. Hence we infer that worms have no sense of hearing.

5. We should be guided by the decisions of our ancestors; for old age is wiser than youth.

Ans.—

This is a case of *unsound analogy.* Old people may be wiser than the young. The points of resemblances between old age and antiquity are not essential. In fact there is no analogy between ancestors and old age.

6. In decerebrate animals (or in a man when as the result of injury, or disease, or anaesthesis the cord is cut off from the higher centres) certain responses may take place through the spinal cord alone. Thus the knee-jerk, the scratch reflex, and certain postural responses may continue, and the possibility of these reflexes is taken to prove the integrity of the cord at this or the other level.

Ans.—

Here the Method of Agreement is employed. The antecedents can be analysed thus:

Brain, spinal cord,	the response	of knee-jerk,	scratch	reflex etc.
No brain, spinal cord	,,	,,	,,	,,
Anaesthetised brain, spinal cord	,,	,,	,,	,,
Diseased brain	,,	,,	,,	,,

We infer that the reflexes of knee-jerk and others are due to the spinal cord, because it is only the invariable antecedent of it.

7. The fresh-water crayfish has a sense of smell, as is proved by the rapid, way in which it retreats from strong odours. Investigation led to the hypothesis that the sense of small was locatedin the antennules or smaller feelers. This was verified by observing that a crayfish bereft of these appendages did not react to a strong odour, whereas in exactly the same conditions and to the same stimulus another crayfish with its antennules in fact did actively respond.

Ans.—

The method employed is the Method of Difference. We shall analyse the positive and negative instance.

Positive instance :—The presence of antennules—reaction to strong odours.

Negative instance :—The absence of antennules—no reaction to strong odours.

8. A butter-cup leaf, a blade of grass, a fern, a moss, a volvox, and a protococus, all contain green colouring matter. I infer that all members of the vegitable kingdom contain green colouring matter.

Ans.—

The method employed here is enumeration. After observing a number of instances like buttercup leaf, Volvox, a fern, etc., to be green, I generalise that all plants have green colouring matter.

9. Communism cannot succeed in Great Britain. Look at the condition of Russia.

Ans.—

This is a case of *unsound analogy*.

10. It has been found that linnets when shut up and educated with singing larks—the skylark, wood

lark, or titlark will adhere entirely to the songs of these larks, instead of the natural song of linnets. We may infer therefore, that birds learn to sing by imitation, and that their songs are no more innate than language in man.

Ans.—

The argument employs the Method of Agreement The antecedents can be analysed thus:

Linnet when breeded with the sky lark produces the song of the skylark.

Linnet when breeded with the woodlark gets the song of the woodlark.

Linnet when breeded with the titlark sings like the titlark.

Hence we infer that the singing of animals is due to their imitation. They are not innate in the birds.

11. Gilbert formed a small sphere of a magnetite (lodestone) and observed the behaviour of small pieces of iron placed on the sphere. He found that a bit of iron tended to be along a meridian line of this spherical magnet, just as does a compass needle on the surface of the earth. From these and other experiments he came to the conclusion that the terrestrial globe is itself a magnet.

This is an example of *sound analogy*. A small sphere of lodestone behaves in the same way like that of the earth. A bit of iron tends to be along a meridian line of the ball of the lodestone, just like a magnetic needle on the surface of the earth. Therefore we infer that the earth is also a magnetic sphere. Our conclusion has very much probability because the points of resemblance are essential.

EXERCISE XX.

I. Explain the logical character of the following arguments and examine their validity.

1. The prosperity of America is enough to prove the desiriability of imposing an import tariff on manufactured articles entering this country.

2. That town must be unhealthy: I know three people who live there and not one of them is in good health.

3. The air must be the cause of sound: for (1) when you ring a bell in a vacuum there is no sound; (2) if a little air is allowed to enter into the vaccum, a faint sound is heard; and (3) as more air is allowed to enter the sound increases.

4. We observe very frequently that poor handwriting characterises the manuscripts of able men, while the best handwriting is as frequent with those whose penmanship is poor. We may, therefore, infer that poor penmanship is caused by the influence of severe mental labour.

5. Jupiter gives out more light than it receives from the sun. What is the obvious conclusion, and by what method is it reached.

6. Another indication that the green colour is connected with light may be obtained from the fact that it is found only in the surface regions of plants. If one cuts across a living twig or into a cactus body, the green colour will be seen only in the outer part of the section.

7. Before it was known that light travelled in waves, it was known that sound did so. Light and sound were both capable of being reflected, and the direction of their reflection obeyed the same law, that the angle of reflection is equal to the angle of incidence. From these facts, it was inferred that light, like sound, travelled in waves.

8. When von Siebold and his fellow-workers had convinced themselves indirectly that certain bladder-worms, e.g., those which occur in the pig and and the ox, were the young stages of certain tape worms which occur in man, they made the crucial experiment of swallowing the bladder worms. By becoming soon afterwards infected with the tape worms they proved the truth of their theory.

9. No body can be healthful without exercise, neither natural body, nor politic; and certainly, to a kingdom or estate, a just and honourable war is the true exercise. A civil war, indeed, is like the heat of fever;

but a foreign war, is like the heat of exercise, and serves to keep the body in health.

10. It was pointed out, however, that in some cases of partial paralysis of the limbs with which these nerves communicate, motion alone is lost, while the power of sensation is retained; in other cases, the reverse condition obtains. This seems to show (What? and How?).

11. During the retreat of the Ten Thousand a cutting north wind blew in the faces of the soldiers; sacrifices were offered to Boreas, and the severity of the wind immediately ceased, which seemed a proof of the god's causation.

CHAPTER XXIII

FALLACIES.

A fallacy (*hetvabhasa*) is a mistake in reasoning. It is due to either the violation of a logical principle or verbal confusion. There are four kinds of fallacies (1) Formal fallacies (2) Inductive fallacies (3) Fallacies due to language (4) Fallacies due to presumption.

(1) Formal fallacies consist of fallacies of deductive logic like illogical conversion, undistributed middle, etc.

(2) Inductive fallacies are those which are incident to induction. They are non-observation, mal-observation etc.

(3) The following are the fallacies due *to language.*

1. Amphiboly

The fallacy of amphiboly (*chala*) arises when there is an ambiguous grammatical structure. A statement is said to commit this fallacy when it admits of double interpretation e.g. 'The wolf the shepherd killed' It is doubtful whether it was the wolf or the shepherd that was killed. Many utterances of the ancient oracles are of a similar nature e.g., 'The Romans, the Greeks shall conquer'.

2. The Fallacy of Accent

The fallacy of Accent is due to the accent or emphasis being placed on the improper words in a sentence. It consists in misinterpreting a sentence by unduly accenting some particular word in it e.g. 'Thou shalt not bear false witness against thy

neighbour' may be made by a slight emphasis on the last word to imply that we are at liberty to bear false witness against the other persons.

3. The Fallacy of Composition

The fallacy occurs when we affirm something to be true of a whole, which holds true only of one or more of its parts when taken separately. It is arguing from a term used distributively to one used collectively. If the same term is used distributively in the premises and collectively in the conclusion, then we commit the fallacy of composition e.g.

> All the works of Shakespeare cannot be read in a day.
>
> The play of Hamlet is a work of Shakespeare.
>
> ∴ The play of Hamlet cannot be read in a day.

4. The Fallacy of Division

This fallacy consists in assuming that what is true of a whole is also true of the parts taken separately. In this fallacy, the same term is used collectively in the major but is used distributively in the minor or conclusion.

> The Italians are musical
>
> Mussoloni is an Italian
>
> ∴ Mussoloni is musical.

5. The Fallacy of Accident

The fallacy of Accident occurs when there is a confusion between the essential properties and accidental ones. The fallacy is committed when a wrong application of a general rule to a particular instance is made, an application not warranted by some accidental circumstances e.g.

Whoever kills another should suffer death
A soldier kills his enemy
∴ A soldier should suffer death.

(4) The following are the fallacies of pre-*supposition or confusion of issue.*

1. Petito principii or Begging the Question

The fallacy of petitio principii (*prakarara sama*) is committed when we either assume the proposition we are proposing to prove, or prove it by premises which can only be proved by means of the proposition itself. In this there is only a show of proof e.g.

All the books in the shelf are logic books
This is a book in the shelf
∴ This is a logic book.

In this syllogism we have already assumed the truth of the conclusion in the major premise. A special form of this fallacy is called arguing in a circle (*circulus in probando*) e.g., Morphine produces sleep because it has the sleep-producing quality in it.

2. Question-Begging Epithets

Certain names or phrases may beg the question directly in terms which they apply or may tend to produce misleading associations. The party's cries like 'honest money' 'the people's cause' are question-begging epithets.

3. The Complex Question

It is only an interrogative form of petitio principii. It is not merely a question, but rests on a false assumption e.g., Why does a fish when dead weigh more than when alive ?

4. Ignoratio Elenchi

The fallacy of ignoratio elenchi is committed when we evade the point at issue. The reason adduced is generally beside the point e.g. Higher education is of no avail since it does not help in later life.

5. The argumentum ad hominem

This is an argument directed against the person making a statement instead of against the statement itself. Politicians generally attack the persons rather than their principles. In Indian logic this is called *vitanda.*

VARIOUS EXERCISES WORKED OUT.

I. State the fallacies committed in the following arguments if any:—

1. John went to Bombay and then to Delhi by express train.

Ans.—

This is an example of the *fallacy of amphiboly.* The statement may mean that John went either to Delhi or Bombay in express train.

2. The earth cannot be round; for if it were, the water in the Suez Canal would flow out at both the ends.

Ans.—

The argument commits *the fallacy of Accident* for the flowing of water at the ends of the Suez Canal is an accidental thing which has no connection with the earth being round.

3. The object of war is durable peace; therefore soldiers are the best peace-makers.

Ans.—

This argument commits the *fallacy of division.* 'Soldier' is used distributively in the conclusion and used collectively in the premise.

4. Seeing that abundance of work is a sure sign of industrial prospesty, it follows that fire and hurricane benefit industry, because they undoubtedly create work.

Ans.—

The argument is an example of ambiguous middle. In the major premise abundance of work, or creation of work means one thing. In the minor, fire and hurricane creating work means another thing.

5. The end of life is perfection ; death is the end of life ; therefore death is the perfection of life.

Ans.—

This is also an example of *ambiguous middle.* In the major premise 'the end of life, means one thing, in the minor it means another thing.

6. The governor of a country ought not to be blamed for using his influence to further his religious views for every man has a right to inculcate his own opinions.

Ans.—

This is an example of *ignoratio elenchi.* This is arguing beside the point.

7. Gold and silver are wealth of the country therefore the diminution of gold and silver of the country by exportation is diminution of the wealth of the country

Ans.—

This argument commits the fallacy of composition. In the first half of the statement, 'gold and silver' are used distributively, and in the second half they are used collectively.

8. The French are vivacious. Bergson is a Frenchman, therefore he is vivacious.

Ans.—

The argument commits the fallacy of division. In the major premise, 'the French' is used collectively and in the minor it is used distributively.

9. One can live without food ; for one can live without bread or potatoes or porridge or any other kind of food.

Ans.—

The argument commits the *fallcy of composition.* In the second half of the statement food is used distributively and in the first half food is used collectively.

10. In reply to the speaker's argument,it need only be said that two years ago he himself advocated the very principles he now opposes.

Ans.—

This is an example of *argumentum ad hominum,* since there is an attack on the person rather than on his principles.

11. You say that this book is inaccurate; but I saw an excellent review of it.

Ans.—

This is an example of *argumentum ad verecundiam.* This argument proves the accuracy of the book by referring to the opinion of a reviewer.

12. How can you hold that self-government is good and deny that India should govern itself.

Ans.—

A man can really believe in the goodness of self-government at the same time admitting that India cannot be self-governed. In holding such a view we do not commit any fallacy. In the statement that self-government is good, it is used collectively the word 'self-government in India' is used distributively because it refers to an instance of self-government. Hence we cannot assert that self-government in India is good, if so we commit the fallacy of division.

13. I will not do this act because it is unjust; I know that is unjust because my conscience tells me so, and my conscience tells me so because the act is wrong.

This argument commits the fallacy of *petitio principii.* The reason we give for the conclusion is only a reassertion of the proposition to be proved. The argument is circular.

EXERCISE XXI.

I. State the fallacies committed by the following arguments :—

1. Every member of a jury is liable to error ; therefore we can place no confidence in the decision of the jury.

2. Good men write good books ; this is a good book and therefore its writer is a good man.

3. He who calls you a man speaks truly ; he who calls you a fool calls you a man ; therefore he who calls you a fool speaks truly.

4. When Croesus was about to make war upon Cyrus, King of Persia, he consulted the oracle at Delphi, and received for an answer, that if he should wage war against the Persians, he would overthrow a mighty empire.

5. The great plea for increase of armaments is that any nation which makes itself strong makes itself respected.

6. He condemns Napolean and Caesar ; but Napolean and Caesar are great men ; therefore he condemns great men.

7. He is innocent, for he has faced his accusation ; a guilty man would run away.

8. The killing of living creature is sometimes necessary ; murder is the killing of living creature ; therefore murder is sometimes necessary.

9. Water is a liquid substance, ice is water and therefore ice is liquid.

10. It is not right for you to devote all your time to archaeological research, for if all men did so, the business of the world could not go on.

11. Lord Chancellor Thurlow said that the corporations have neither bodies to be punished nor souls to be damned ; they therefore do as they like.

12. Partners in the same enterprise have the same interest. How can there be any antagonism between my workmen and me ?

13. Nations are justified in revolting when badly governed for every people have a right to have a good government.

14. England has a good coinage, and is a very wealthy country, therefore it may be inferred that other countries having gold coinage will be wealthy.

15. The student of history is compelled to admit the law of progress, for he finds that society has never stood still.

16. Logic and mathematics both furnish excellent formal discipline ; therefore the latter may be regarded as a branch of the former.

17. No man desires pain ; and without pain your friend's cure is impossible. Therefore he will not desire to be cured.

The Madras University Intermediate

Question papers

1931 -- 1934.

THE MADRAS UNIVERSITY
INTERMEDIATE QUESTION PAPERS.

1951 MARCH FIRST PAPER.

I. How far is it justified to distinguish between logic as a science and logic as an art?

II.-a. What is meant by connotation? What is its importance in logic?

b. In how many different ways are terms distinguished in logic? Illustrate your answer with examples.

III-a. Give the genus, differentia, a property and an accident of logic, rectangle, college, corporation.

b. Test the correctness of the following definitions.

1. Man is a featherless biped.
2. Science is a branch of knowledge.
3. A square is a four-sided figure.
4. A plane triangle is a three-sided rectilineal figure.

IV. Give, wherever, possible, the contrary, contradictory, converse and the contrapositive of the following.

a. If a man seeks pleasure, he can never attain pleasure.

b. All tyrants are unhappy.

c. Not all despots are cruel.

V-a. Prove that no syllogism in fourth figure can be correct, which has a particular negative among its premises or a universal affirmative for its conclusion.

b. Prove that when the minor term is predicate in its premise the conclusion cannot be universal affirmative.

VI-a. Discuss the logical validity of the following.

1. All novels are false; therefore no novel reader is a lover of truth.

2. Good always triumphs and vice always fails; therefore victor cannot be wrong nor the vanquished right.

3. Bodies subject to gravity descend, but smoke ascends, therefore smoke is not subject to gravity.

b. Construct an argument in the form of a dilemma in favour of the freedom of press.

SECOND PAPER.

I. What is meant by induction? What is the difference between induction proper and enumeration of instances?

II. Either explain clearly the presupposition of induction or what do you understand by cause as the term is used in the natural sciences.

III. What is the value of analogy and what are its limitations as a method of explanation?

IV. Discuss the question whether it is possible to reduce the inductive methods to one.

V. What is the place of hypothesis in induction? What distinguishes a hypothesis from a mere guess?

VI. 'Observation seems easy and simple and passive: we have, as it were, simply to open our eyes and we see certain things' With reference to this statement consider the question whether observation can be strictly separated from explanation.

1931 SEPTEMBER FIRST PAPER.

I. Explain:—

'Logic deals with the form and not the matter of thought'.

II. How do you distinguish between connotation and denotation? Upon what grounds would you decide whether the name: 'The Right Honourable Srinivasa Sastry' has denotation or connotation only or both?

III. What is meant by logical division? Consider how for the following divisions are logical.

a. Indians into Hindus, Adi-Dravidas, Christians, Moplas, the Maharajah of Cochin, Tamilians, the President of the Legislative Assembly, Mohammedans and Non-Brahmins.

b. Books into Literary, Philosophical, Poetical, Interesting and Cloth-bound.

c. Men into short and tall.

IV. Reduce to logical form and give the contra-positives of the following.

a. It is an ill wind that blows no body good.

b. Only the wise are happy.

c. More haste, less speed.

V-a. Why connot O stand as a premise in the first, as a major in the second or a minor in the third or as a premise in the fourth figure.

b. Show from the general rules of syllogism that in the third figure the minor premise must be affirmative and the conclusion particular.

VI-a. Test the validity of the following :—

1. Madras must be a very hot place, for we never see snow here.

2. As the learning of logical formulae does not give pleasure, it clearly has no value.

3, Gopal is a very bad marksman; hence it is safest to stand in the front of the object he is aiming at.

b. What is meant by sorites? What are the logical rules governing it?

SECOND PAPER.

I. What is the special function of induction as distinct from that of deduction?

II. What do you understand by the uniformity of nature? What is the place of this conception in Inductive Logic?

III. What is the method of Concomitant Variations and for what purpose is it chiefly valuable?

IV. What is the value of statistical statement from the point of view of induction, and what dangers beset their use?

V. Either, explain, giving an illustration, what is meant by a crucial experiment. Why is it difficult to arrange a crucial experiment?

Or what fallacies arise from the use of words?

VI. What is a hypothesis? Explain how a good hypothesis is arrived at showing the part played by imagination and reason respectively in its formation.

1932 MARCH FIRST PAPER.

I. 'Logic is the art of winning an argument' Examine the statement.

II. 'Extension and intension vary in inverse ratio' Discuss.

III. Consider in detail whether the following terms are connotative :—

A yard, Mahatma Gandhi, Wisdom, Non-Mussalman.

IV-a. Consider the relation between Definition and Division.

b. Explain the following divisions :—

1. Students into men, women, post-graduates, intermediate, and rich.

2. Terms into collective, general, abstract and singular.

V. State the logical relation, if any, between the first of the following propositions and the rest :—

1. Good men are wise.
2. Unwise men are not good.
3. Some unwise men are good.
4. No good men are unwise.

VI. Draw as many inferences as you can from the following propositions :

a. All is well that ends well.
b. Only the educated are fit to vote.
c. Humour is not given to all.

VII. Explain why:

a. The middle term should be distributed at least once

b. the conclusion in Fig. III must be particular

c. the middle term cannot be distributed twice when the conclusion is universal.

VIII. Explain the validity of the following arguments.

a. A poet is a man, a good poet is a good man

b. Seeing is believing; hence I refuse to believe in God.

Moral exhortations are useless for good men do not need them, and bad men will pay no heed to them.

SECOND PAPER.

I. 'The difference between deduction and induction is not one of principle but of starting point' Discuss

III. What is meant by the uniformity of nature? Is it consistent with the occurrence of luck and magic?

III. Is analogical inference is ever conclusive? Explain and illustrate the conditions which arguments based on analogy should fulfil.

IV. State and illustrate the method of Residues. What is its main function in science?

V. What is the function of statistics in the scientific investigation?

VI. What is a negative instance? Bring out by concrete examples its importance in induction.

VII. Explain the validity of any two of the following statements.

a. Satyagraha cannot succeed in India for have not sheep offered passive resistance against the tiger for ages.

b. Judge :—" Five witnesses have shown that they have seen you stealing the purse, what have you to say?"

Culprit :—' I can produce sixteen witnesses who can all honestly swear that they never saw me stealing the purpose

c. Children are bright and interesting, but adults are dull and uninteresting. What has happened in the middle? Education.

1932 SEPTEMBER FIRST PAPER.

I. 'We do not talk in propositions; people can reason, without the help of logic' Discuss.

II-a. Distinguish between concrete and abstract terms giving suitable illustrations.

b. Classify, equation, non-brahmin, caste, nothing

III-a. State briefly the rules of definition.

b. Comment on the following definitions :—

1. Time is the moving image of eternity.
2. Pleasure is the opposite of pain.
3. A university is an eductional institution.
4. Man is a human being.

IV. State the logical relation between the first of the following propositions and the rest :—

a. There are no negroes who are not strong.
b. Some strong men are not negroes.
c. Some weak men are negroes (weak—not strong)
d. Those who are not negroes are not strong.

V. Put the following into propositional form and draw as many immediate inferences as possible.

1. That is not true.
2. It is never too late to mend.
3. No admittance except on business.

VI. Show that an O proposition cannot stand as a premise in Fig. i, as a major in Fig. ii, as a minor in Fig. iii, or as a premise in Fig. iv.

VII-a. Why is the IE form inadmissible in any figure while the, form EI is valid in all?

b. Construct as arguments to illustrate the fallacy of the following arguments :—

1. He must be a Scotsman, for no Scotsman can see the point of joke.

2. He is a very bad marksman; hence it is safest to stand in front of the object he is aiming at.

3. Valid inference is impossible, since for valid inference we require novelty, and for validity we must limit ourselves to what is given.

Second Paper.

I. What part does deduction play in inductive enquiry?

II. Can the postulate of induction be proved? If so, how?

III. Indicate with illustrations the special errors to which observation and experiment are liable.

IV. Distinguish between the popular and logical uses of the term 'cause'. Give instances.

V. Describe and illustrate the method of concomitant variations. What are its chief uses?

VI. Write short notes on:—Composition of causes, crucial instance, negative instance, empirical law.

VII. Examine the validity of any two of the following statements:

1. You say that this book is inaccurate but I saw an excellent review of it.

2. Representative government in India is bound to succeed; for has not democracy made England a prosperous country?

3. Drink must be the cause of poverty, for most poor people drink.

1933 March-First Paper.

I. How would you define logic? How does the logician's interest in reasoning differ from that of the psychologist?

II-a. What is the difference between connotation and denotation? Illustrate by reference to orange.

b. Discuss if there are terms without connotation.

III. Test the correctness of the following definitions.

1. Painting is visualised music.

2. A nut is something with a shell and good to eat.

3. The division of soldiers into artillery, cavalry, privates, volunteers.

4. The division of games into those that are athletic and those that are intellectual.

IV. Give, wherever possible, the converse, the contrapositive and inverse of the following.

1. Only children believe in miracles.

2. He who digs a pit for others falls in himself.

3. Few important discoveries are due to accident.

V. Show, with the aid of the general rules of the syllogism that (a) when the major term is predicate in the premise, the minor premise must be affirmative (b) I E O is invalid in every figure.

VI. Frame a concrete argument in Baroco and reduce it directly to the first figure.

VII-a. What are the chief sources of fallacy in a dilemma?

b. Rebut the following dilemma: if a thing advertised is good people would go in for it without their attention being drawn to its merits; if the thing advertised is not good, it is immoral to praise its qualities. Hence advertisement is either not necessary or not moral.

VIII. Identify the following arguments:—

1. If the strike had been called off, the men would be back at work; but since the men are not back, we suppose that strike has not been called off.

2. Of university professors some are good teachers and some are zealous investigators; A is an intelligent teacher; therefore he is not a zealous investigator.

3. Ice is water; water is liquid; therefore ice is liquid.

SECOND PAPER.

I. It is correct to say that in induction we proceed from the known to unknown? If not, how would you correctly describe inductive procedure?

II. Either, Distinguish between observation and experiment. Are these methods specially applicable to any particular kinds of investigation or to particular classes of facts?

Or, what are the different senses in which the word cause is used? Why is the doctrine of the plurality of causes inconsistent with the scientific conception of cause?

III. Explain and illustrate the method of difference in the determination of causal connection.

Or, Discuss the relative merits of the Method of Agreement and the Method of difference.

IV. Explain the nature of analogical inference and bring out use to which it is put in scientific investigation.

V. What is the part played by hypothesis in scientific induction? What are the tests employed for determining the value of hypothesis?

VI. Explain and illustrate the fallacies of induction (a) due to imperfect observation and (b) those due to imperfect reasoning.

SEPTEMBR SECOND PAPER:

I. Distinguish between a science and an art. Discuss whether logic is a science or an art or both.

II. What is the division by dichotomy? Discuss its merits.

III. State the requirements of logical definition. Illustrate your answer.

IV. Given the truth of the proposition 'No minors are voters,' what can be inferred about

(1) Persons who are not minors and (2) Persons who are not voters.

b. What is meant by oppositional inference?

V. State the logical relation that exists between the first of the following propositions and each of the rest.

1. All congressmen spin yarn.

2. All persons who do not spin yarn are persons who are congressmen.

3. Some who spin yarn are not persons other than congressmen.

VI. Show with the aid of general rules of the syllogism that (a) in the second figure the major premise must be universal, and (b) in the third figure the minor premise must be affirmitive.

VII. Prove the rules governing correct inference in the mixed hypothetical syllogism.

8. Identify the following arguments and test their validity.

1. Italians are a musical nation; therefore Mussoloni must be musical.

2. All good citizens are ready to defend their country and they vote regularly at elections; therefore all who vote regularly at elections are ready to defend their country.

3. If the student takes notes, his mind is distracted; if he does not, his memory may let slip some cardinal point. The student either takes notes or does not.

SECOND PAPER.

I. Show that deduction and induction are not independent but interdependent.

II. What are the conditions to be satisfied before one can say that two things or events are causally connected ?

III. Either (a) compare the method of single agreement with that of simple enumeration, so as to bring out the relative merits and defects of each method or (b) Explain and illustrate the Joint Method of Agreement and Difference.

IV. What are the conditions under which an argument from analogy can be rendered convincing ? Bring out the defects of analogy as a form of argument.

V. What is the relation between description and explanation in the scientific investigation of facts ?

VI. Either (a) what is meant by chance ? Is it consistent with the postulate of induction ? What part does it play in inductive methods ?

Or Explain and illustrate.

1. Perfect induction.
2. Empirical law.
3. Negative instance.
4. Median value.

MARCH 1934 FIRST PAPER.

I. 'Logic is the science of reasoning' 'Logic is the art of thought' Do you consider that these two definitions are conflicting ?

II (a) (i) When is a term said to be. equivocal, (ii) general, (iii) negative, (iv) non-connotative

(b) Discuss if connotation means all the known qualities of a thing.

III. Test the correctness of the following definitions and divisions.

(a) A shrub is a plant not exceeding two feet in height.

(b) Finance is the vehicle of government.

(c) The division of members of the legislative council into non-officials, swarajists, and justicites.

(d) The division of religions into monotheism, polytheism, Buddhism, and Christianity.

IV. (a) Suppose a man said 'All children are greedy' and you disagreed with him, would you reply with an E or O proposition? Which would give you the best chance of proving yourself right?

b. What, if any, is the relation between the following assertions?

1. A false weight is an abomination to the Lord.
2. A just weight is His delight.

V. Draw as many inferences as you can from the following propositions :—

1. Not all philosophers are idealists.
2. Only healthy digestions can tackle veal.
3. All swallows are migrants.

VI. What rules of (a) the figures, (b) the syllogism are broken by the following moods :—A E E in figure iii, and I A I in figure ii.

VII. Justify the following statements :—

a. When the middle term is the predicate of the premises of a syllogism the major premise must be universal.

b. In hypothetical syllogisms the denial of the antecedent yields no valid conclusion.

VIII. Examine the following arguments :—

1. No bachelor has a wife; this man has no wife; he is, therefore, a bachelor.

2. If a shop-keeper closes his shop for a day, he loses custom; so that if all the shop-keepers of the town do so on the Ayudhapuja day, they will lose custom.

3. No honest lawyer will plead for the accused person, for the accused is either guilty or innocent. If he is guilty, he ought not to be defended; and if he is innocent, it must be apparent to his judges.

SECOND PAPER.

I. Explain what is meant by uniformity of nature. Can it be proved?

II. What is meant by (a) plurality of causes, (b) reciprocity of cause and effect?

III. What do you understand by 'perfect induction'? Do you regard it as true induction? Give reasons for your answer.

IV. What are the uses for induction of the method of statistical enumeration?

V. Compare the Method of Difference with the Joint Method of Agreement and Difference in respect of (a) facility of application, (b) certainty of the conclusion.

VI. Explain the Method of Residues. When can it prove that one event is the cause of another, and when can it only suggest an inquiry into causation?

VII. Describe the process of verification of hypothesis. Has the process formal certainty?

VIII. What is the method adopted in each of the following arguments?

Estimate the value of the conclusion suggested in each case:—

a. Lord Curzon, arguing for the continued hereditary chamber, says:—'The hereditary principle is established in every branch and aspect of national life. We have hereditary bankers, lawyers, and cotton spinners. Why should it be a blot and offence when applied to the House of Lords.

(b) Overdriven cattle, if killed before recovery from fatigue, become rigid and putrefy in a surprisingly short time. A similar fact has been observed in the case of animals hunted to death; cocks killed during or shortly after a flight; and soldiers slain in the field of battle. These various cases agree in no circumstances directly connected with the muscles, except that these have been subjected to exhausting exercise.

48477

Printed at the 'Pammi Press', Madras.